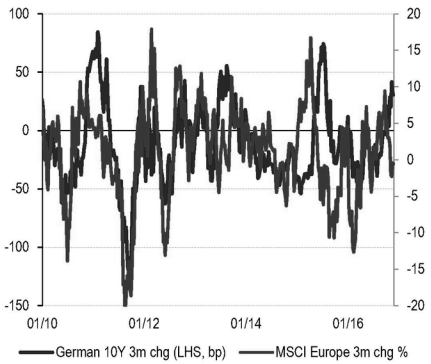
+1.0% after 3 months and +3.7% after 6 months. Subsequent returns were positive in six of the eleven episodes and negative in the other five. Those stats are a little worse than the comparable numbers for the full sample but don't indicate that a bond yield spike is definitively negative for equities.

Chart 40: Rolling 3-month change in bond yields and equities



Source: BofA Merrill Lynch Global Research, Bloomberg

Table 3: Track record mixed for stocks following bond yield spike

Subsequent equity market returns following spike in bond yields (3m change >2.5SD)

3m change in bund yields hits peaks >2.5SD	Next 3m %	Next 6m %	Prior 3m %
10/06/1983	4.4	9.2	7.9
08/03/1985	5.3	10.2	11.1
02/03/1990	5.9	-6.9	-0.4
25/03/1994	-7.5	-4.7	-3.4
15/03/1996	4.7	7.0	4.9
09/07/1999	-3.6	9.8	3.7
22/08/2003	1.0	10.4	12.1
15/06/2007	-7.1	-6.1	11.1
13/06/2008	-8.1	-32.1	1.6
26/11/2010	6.0	3.7	7.2
08/05/2015	-1.2	-5.6	5.9
Median return	1.0	3.7	5.9
% positive	55%	55%	82%

Source: BofA Merrill Lynch Global Research, Bloomberg

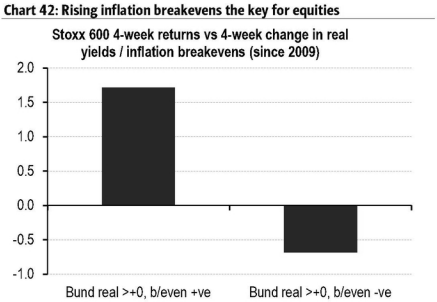
It matters why yields are rising – higher inflation breakevens key for stocks.

Digging a little deeper shows that the underlying dynamics in the bond market matter. Essentially rising inflation breakevens is the key driver for equities. Even when real yields are rising it is the change in implied inflation that has correlated most strongly with equity returns in recent years. Looking at 4-week rolling returns since 2009, in the periods that real yields rose Stoxx 600 returns were a median +1.7% if breakevens were also higher at the same time. In contrast a combination of higher real yields and lower inflation breakevens led to a median -0.7% return.

Chart 41: Inflation breakevens on the rise in recent bond market move

Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 42: Rising inflation breakevens the key for equities



Source: BofA Merrill Lynch Global Research, Bloomberg

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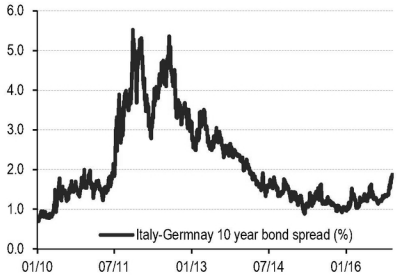
What then is the prospect for inflation expectations from here? Breakevens have moved significantly already in the context of the Euro area inflation outlook. 5-year, 5-year forward inflation swaps have recovered all the ground they lost earlier in 2016 in Europe and are back to end 2014 levels in the US. At 1.6% in Europe and 2.44% in US there is arguably more limited upside. A return to the range for inflation expectations that prevailed in 2013/14 before the oil price collapse would imply another 30-50bp from here. However, at least in the case of Europe our economists see the outlook for inflation remaining very subdued. Overall we would conclude that equities can see upside from here if bond yields rise towards our fixed income team's targets as long as inflation expectations are stable to rising at the same time.

Rising bond yields pushing Italian spreads wider a risk for equities. Although rising core rates are not necessarily problematic for stocks, an important caveat is the fall out in other parts of the bond markets – particularly in the periphery. The equity market in Europe is sensitive to rising Italian bond spreads – exhibiting a negative correlation in recent years. This is an important risk at the current juncture given the upcoming referendum in Italy and ECB decision on QE extension. Should Italian bond spreads widen significantly from here it would likely weigh on equity valuations, keeping the risk premium high in Europe and in turn offset or outweigh the benefit from rising nominal growth expectations globally. This is perhaps the biggest potential problem for equities in the scenario that bond yields rise further from here. The ECB decision on QE extension is an important risk event in that context. As our economists have discussed in a recent note the risks of an ECB delay in the short term are increasing but their base case remains a QE extension with some tweaks of the capital key – a relatively benign outcome for peripheral sovereigns.

Chart 43: Inflation breakevens – room to normalize further?

Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 44: Wider Italian bond spreads correlate negatively with equities



Source: BofA Merrill Lynch Global Research, Bloomberg

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Sector Strategy

Markets due a period of consolidation in the short term. The reflation trade has run hard and we've taken some chips off the table in recent weeks by cutting our overweight positions in Banks and Basic Resources to neutral and reducing the size of our underweights in some Defensive sectors. In the short term we look for markets to consolidate. Near term risk reward is also a little poorer in light of event risks around the Italian referendum, OPEC's decision on a potential cut in oil production quotas and the ECB's decision on QE extension.

Look for another leg to the reflation trade in the coming months. We would look for another leg to the cyclical and reflation rotation in the next 1-2 quarters as evidence of stronger global growth and rising inflation materializes. We will look to re-enter sector positions that benefit from global rotation when short term risk reward improves. However, we would look for the pace of the rotation to moderate and become less binary from here. The upside from here for bond yields is more limited. With that in mind we are likely to be more selective in reflation vs bond proxy positions.

Politics likely remains an overhang through 1H 2017. Another reason to run a less binary portfolio over the coming months is the potential for political uncertainty to weigh on European markets. Attention near-term will focus on Italy but the French Presidential elections loom in April / May and the tail risk of a Marine Le Pen victory will act as an overhang for Europe in the coming months. It suggests 22017 may well be a year similar to 2016, in which the major indices in Europe have traded in ranges for large parts of the year.

Value in some Defensive bond proxies. Valuation looks quite compelling already in some of the bond proxy sectors. Utilities and Healthcare are both trading at the low end of relative valuation ranges and have decent fundamentals in the view of our analyst team. However, rising government bond yields remains the major potential headwind in coming months. We are overweight both sectors.

Financials – neutral following the strong recent rally. Banks have re-rated aggressively, taking PE-relative back to average levels. However, the sector continues to have uncertain prospects for EPS recovery given continued ultra-low policy rates in Europe and ongoing tail risks from periphery are an overhang on the sector. Continued long only positioning remains a potential support for the sector should rates and yield curves renew their widening moves. A Risk reward may be better in Insurance – the sector still offers the second highest DY in the market (and relative DY is still at 90th percentile of the range since 2004).

Global quality Cyclicals – waiting for an entry point. Many cyclicals have performed less strongly in the recent rally than Resources and re-rated less aggressively than Financials. With relative PE valuations in-line with or below 17-year averages for the likes of Industrials, Chemicals and Technology we will look for opportunities to build positions in cyclical areas in the coming months. Overowned positioning has been something of a negative for several of these areas (notably Tech) and any signs of a correction could be a catalyst to re-enter an overweight in the sector.

Media – raise to overweight. With the outlook for markets set to become less binary we will look to add exposure to quality cyclical areas. One such sector that has lagged this year is Media, making this an interesting entry point. The sector is something of hybrid combining defensive and cyclical components and high and low quality. Media in particular has come back a long way following a six-month period of sustained underperformance.

Overweight Oil position dependent on OPEC. As we go to press, the OPEC decision on a deal to cut oil supplies is pending. Our commodity strategists' base case has been for some kind of deal, with upside into the mid $50s for a deal to cut 1 million barrels per day. However, in the case OPEC fails to agree any deal they see WTI dipping back

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below $40. In other words, the outcome is highly binary in the short term for crude and related equities. We flag to investors that we would consider reducing our weighting in the event of no deal.

Assuming OPEC does cut production and oil prices recover up to the high $50s per barrel, as per our commodity strategists views, earnings and cash flows can recover significantly in the coming 12-18 months. Our Oil analysts model between 8 and 17% upside to operating cash flows in 2017 for European integrated stocks if assumed crude prices are increased $10 from $50 to $60. That makes the highest DY in market at ~6% more sustainable out of FCF coverage.

Cautious UK domestic (underweight Retail, Travel & Leisure). We are cautious on domestic UK exposure and underweight Retail and Travel & Leisure. To our mind, these companies face a lose-lose trade-off of maintaining margins by passing on higher costs at the expense of volumes, or face margin pressure by absorbing these costs in order to sustain current volumes. Building inflationary pressures point to a post-Christmas consumer squeeze. This could be further compounded OPEC cuts and oil prices rise. The Retail sector is also facing structural margin pressures and unattractive valuations. In Travel & Leisure (two thirds UK listed), profitability is declining from peak levels. Note our analysts also see structural pressures on airlines from overcapacity and competition. See below for more details.

Table 4: European Sector Allocation

Sector	Ticker	Index Weight %	Stance	Delta (bp)	Portfolio Weight %	Portfolio / Benchmark %
Oil&Gas	SXEP	4.6	o/w	+150	6.1	132%
HealthCare	SXDP	12.5	o/w	+150	14.0	112%
Media	SXMP	2.6	o/w	+100	3.6	138%
Utilities	SX6P	3.9	o/w	+100	4.9	125%
Trav&Leisr	SXTP	1.8	u/w	-150	0.3	15%
Food&Bevrg	SX3P	5.9	u/w	-150	4.4	75%
Retail	SXRP	3.1	u/w	-200	1.1	36%
		100.0		+0	100.0	0%

Sector	Ticker	Index Weight %	Stance	Delta (bp)	Portfolio Weight %	Portfolio / Benchmark %
Autos&Parts	SXAP	3.2	n	0	3.2	100%
Banks	SX7P	12.4	n	0	12.4	100%
BasicResou	SXPP	3.0	n	0	3.0	100%
Chemicals	SX4P	5.0	n	0	5.0	100%
Constr&Mtr	SXOP	3.0	n	0	3.0	100%
FinServ	SXFP	1.9	n	0	1.9	100%
InduGd&Ser	SXNP	11.9	n	0	11.9	100%
Insurance	SXIP	6.4	n	0	6.4	100%
Per&HouGds	SXQP	8.8	n	0	8.8	100%
Real Estate	SX86P	1.9	n	0	1.9	100%
Technology	SX8P	3.8	n	0	3.8	100%
Telecomm	SXKP	4.1	n	0	4.1	100%

Source: BofA Merrill Lynch Global Research, Bloomberg

Reflation rotation – tactically got very stretched

Over the last two weeks we cut our weightings in Basic Resources and Banks to neutral. That was in response to the signals from our technical models all flashing warning signs that the rotation out of bond proxies into reflation beneficiaries had got very stretched tactically. Our Composite Technical Indicators (CTIs) for sector relative performance hit +100 at the recent high in the case of Basic Resources and +94 for Banks and Insurance. These models combine a range of technical indicators including RSIs, MACDs, Bollinger bands and others and +100 represents maximum overbought. Basic Resources relative price has also reached +2.7SD above the 52-week average, the highest reading for the sector since 2010. Financials hit +1SD while other cyclicals have also peaked at +1.5-2SD in recent weeks.

By contrast bonds and equity bond proxies screen as very oversold on these models. All Defensives troughed at -92 or below at some point over the last 4 weeks. On Bollinger scores, relative prices hit between -2.4SD and -3.8SD for the Defensives and also Real Estate. In the case of Utilities (-3.8SD) that is close to a record low. Similarly our CTI readings for macro variables like 10-year Treasury yields, gold and $/yen also hit oversold levels. The models are useful in isolation for highlighting any anomalies in

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recent price action for individual assets. However, the fact that we have had multiple signals across a range of sectors and macro prices is typically a warning that markets have moved too far too fast in a more general sense.

The last comparable episode was in early July in the wake of the Brexit sell-off. At that point Defensives were hitting record over bought signals with Financials and Cyclicals seeing the opposite. Against the backdrop of heightened uncertainty over the effects of Brexit the models provided a great signal to fade the violent rotation.

With these signals in mind we look for a period of consolidation in the rotation trade. The models are short term in nature and are not intended to identify strategic turning points – although like in the case of Brexit they do tend to emphasize when a crescendo is reached. While we would look for another potential leg in some of the reflation trades over the coming months we would prefer to wait for a pull back. The Basic Resources sector provides a useful example in how to use the models tactically. Three times this year prior to the current instance the sector has hit overbought levels on its relative CTI indicator. Previous pullbacks lasted 4-8 weeks and averaged -11% in relative performance terms.

Table 5: Composite Technical Indicators for sector relative returns

(+100 max overbought; -100 max oversold)

Sector	Latest	Since Oct 27 MIN	MAX
Healthcare	-5	-98	-1
Personal & Household Goods	0	-94	0
Food & Beverages	-31	-93	0
Telecom	-25	-92	0
Utilities	-8	-92	3
Technology	0	-88	26
Media	-1	-87	7
Industrial Goods & Services	0	-73	35
Oil & Gas	1	-45	4
Autos	0	-12	8
Chemicals	0	-8	0
Travel & Leisure	0	-27	37
Financial Services	-1	-3	43
Construction & Materials	0	-17	45
Retail	0	-42	90
Insurance	36	0	94
Banks	16	8	94
Basic Resources	9	7	100

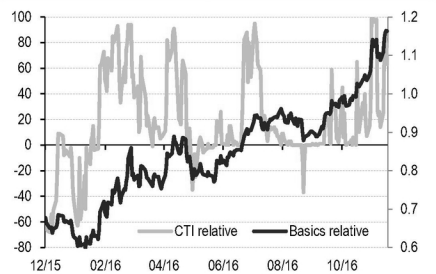
Source: BofA Merrill Lynch Global Research, Bloomberg

Table 6: Bollinger scores –bond proxies 2.5-3.5SD oversold

	52-week Z-Score Recent 1m extreme	Latest
Utility	-3.8	-2.6
Real Estate	-3.4	-2.1
Media	-2.9	-1.8
Food & Bev	-2.6	-2.2
HealthCare	-2.5	-1.8
Telcos	-2.4	-2.2
Travel & Leis	-2.1	-0.7
Retail	-1.5	-0.4
Prs & HH Gds	-1.2	-0.6
Autos	0.8	0.5
Insurance	0.9	0.8
Technology	1.0	0.6
Banks	1.0	0.6
FinServ	1.0	0.6
Industrials	1.5	1.4
Oils	1.6	0.9
Chemicals	1.9	0.8
Construction	2.0	1.2
Basics	2.7	2.2

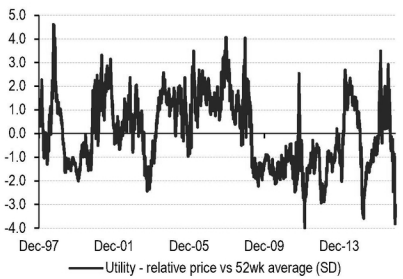
Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 45: Basic Resources 4th overbought signal this year – previous pullbacks last 4-8 weeks and averaged -11% relative



Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 46: Utilities near a record -4SD oversold vs 52-week average



Source: BofA Merrill Lynch Global Research, Bloomberg

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Rotation trade – valuations have moved a long way

While technical metrics suggest a pause is due in the reflation rotation, we have also seen a significant amount of ground covered from a valuation perspective in the market moves to date.

The scatter chart below compares the PE relative change since 8th July (the post Brexit valuation high / low for many sectors) against where PE relative ranks now compared to history. Essentially sectors in the top right have enjoyed a relative multiple re-rating and current relative PE levels are above the median since 1999. Those in the bottom left have seen relative PE multiples de-rate while their current relative PE is below the median since 1999. We make the following observations:

- **Financials have had the biggest re-rating.** Financials re-rated most since Brexit and are now trading around median relative valuation levels. Given the tight link between relative valuations and bond yields in recent years the PE-relatives for Banks and Insurance have also recovered much more than would seem justified by the move in the German 10-year yield. The sectors do screen cheaper versus history on PBV reflecting relatively depressed ROEs especially for Banks. Hence, we think PE multiple expansion from here would need to be driven by improving EPS prospects in the sector – something our analysts are sceptical about.

- **Global Cyclicals trading near or below average relative PE's.** Many global cyclicals have had fairly modest re-ratings since early July and trade on close to median or below valuations. Sectors such as Industrials, Chemicals, Autos, Tech have relative PE multiples 5-10% higher than post Brexit. Relative PE for Chemicals and Industrials are close to post 1999 averages. Construction PE relative does screen as elevated – at the 92nd percentile. Autos, Tech and Travel & Leisure all have PE relatives in the bottom quartile of their post 1999 range. Relative PE valuations look very reasonable on this basis for Tech, Chemicals and even industrials. In part this may reflect higher than historical average ROE – relative PBV is less flattering for Industrials for example.

- **Resources sectors – de-rating as EPS recovers.** Oil and Basic Resources PE relative has declined more than in any other sector. Although both sectors have seen strong price performance this year, PE multiples are declining from very elevated levels earlier this year as earnings bounce back from depressed levels. Since the end of June Basics 12m forward EPS is up +65%, while the sector index price has risen +33%. For Basics and Oil, performance from here is likely to remain a function of EPS momentum rather than valuations.

- **Defensives have all de-rated with Telecoms suffering least.** Defensive sectors have all seen relative valuations decline over the past four months. Healthcare and Utilities are the two sectors with multiples at lower end of the historical range – notably Healthcare at the 14th percentile. Utilities relative PE is also close to the prior low hit in 2013. Telecoms screens as somewhat less depressed form a valuation perspective – notwithstanding the poor sector performance in 2016. PE relative remains well above the median levels since 1999.

- **Staples approaching 2010/14 lows on PE-relative.** Staples have also de-rated severely – in fact Food & Beverage relative PE fell somewhat more than the other Defensives. However, current levels are still somewhat higher versus the historical range (since 1999) than for Healthcare or Utilities. That being said, the PE-relative rose structurally through the 2000s. Over a shorter time frame since 2010 Food & Beverage is also now trading near the bottom quartile. PE-relative is 6-10% above the lows seen in 2010 and 2014 – but those would still allow for healthy 25-30% valuation premiums to the market .

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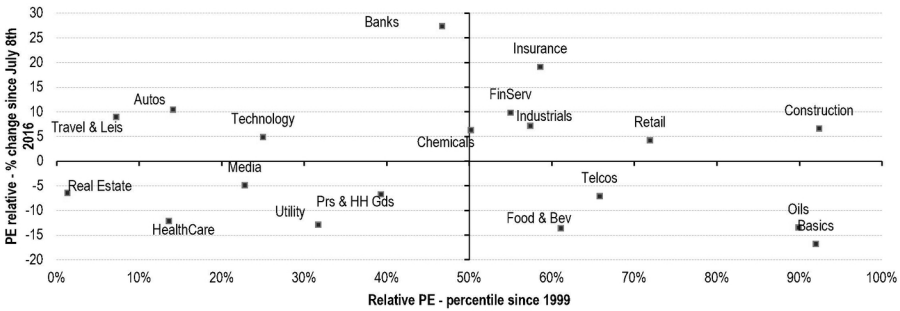
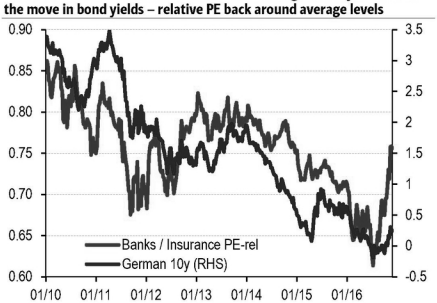
Overall, we find it hard to argue that sectors haven't moved a long way already from a valuation perspective, even against the context of potentially important inflection points in bond yields and earnings. From here we suspect investors may need to more selective in how they play the rotation theme and consider other variables such as earnings momentum, yield, technicals and positioning when allocating across sectors.

Chart 47: Relative PE – recent re / (de) rating compared to percentile ranking of latest relative multiple



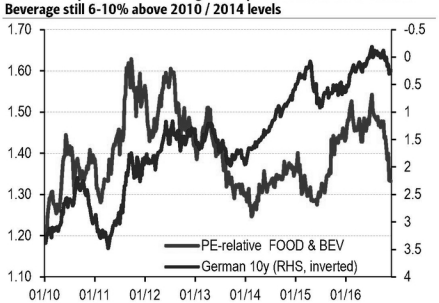
Source: BofA Merrill Lynch Global Research, Datastream, IBES

Chart 48: Financials valuations have recovered significantly relative to the move in bond yields – relative PE back around average levels



Source: BofA Merrill Lynch Global Research, Datastream, IBES

Chart 49: Rapid relative de-rating for Staples – relative PE for Food & Beverage still 6-10% above 2010 / 2014 levels



Source: BofA Merrill Lynch Global Research, Datastream, IBES

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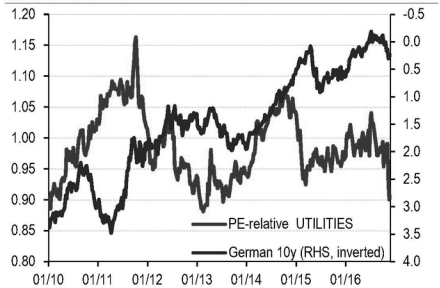
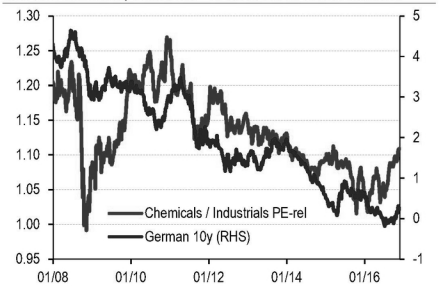
Chart 50: Utilities relative PE close to the 2013 low



Source: BofA Merrill Lynch Global Research, Datastream, IBES

Chart 51: Chemicals / Industrials – re-rated but PE-rel not excessive



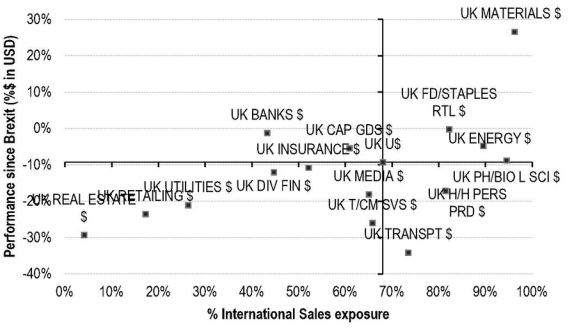
Source: BofA Merrill Lynch Global Research, Datastream, IBES

UK – Waiting for Brexit

It's useful to think about where the UK is today in terms of the four risk factors we identified in our February 2016 Brexit preview: 1) weaker GBP; 2) weaker UK growth; 3) Higher UK risk premia & gilt yields; 4) increased regulatory, political and market uncertainty.

Although we saw a severe risk-off move immediately following the Brexit vote, the only truly significant post-Brexit delta has been a weaker GBP. GBP is down 16% vs USD and 11% on a trade weighted basis. In fact, a simple post-Brexit strategy of going equal weighted long UK-listed sectors with above market international sales exposure vs sectors with below market sales exposure would have delivered ~110% returns in USD.

Chart 52: GBP and sales exposure have been the key determinants for post-Brexit UK equity returns



Source: BofA Merrill Lynch Global Research, Bloomberg, Factset. Performance in USD from 23-June-2016 close to 25-Nov-2016 close.

The currency move contrasts with the other risk factors. To date, UK growth which has held up better than many expected; policy uncertainty has fallen following a sharp spike; gilts are only 2bp higher than June 23rd (although this masks a 85bp rally then 87bp sell-off); and the UK cost of equity is now down ytd. What Brexit, you could ask.

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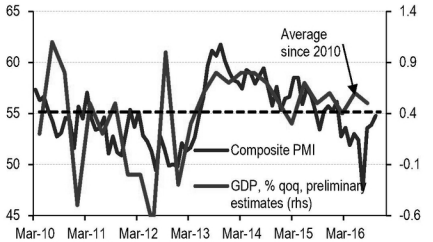
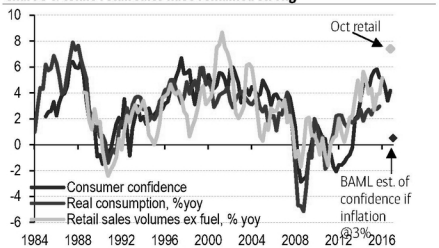
As we outline below, we think it is just a matter of timing. The political certainty created by the swift election of Theresa May plus the Bank of England's interventions have delayed, rather than resolved, the underlying uncertainties caused by the vote.

Chart 53: UK PMIs tanked post-Brexit but have recovered



Source: BofA Merrill Lynch Global Research, Markit, ONS.

Chart 54: While retail sales have remained strong



Retail sales volumes. Source: BofA Merrill Lynch Global Research, GfK, ONS.

2017: Falling growth, negotiations and a consumer squeeze

We think there are clear warning signs that conditions are deteriorating, uncertainty is set to return and a consumer squeeze is coming for the UK.

Falling growth to compound deficit problems

Real gdp is only expected to fall 0.1% in 2016 vs the March forecast. But the UK Office of Budgetary Responsibility expects growth to slip by 0.8% next year (2.2% to 1.4%) and 0.4% on 2018 (2.1% to 1.7%) vs March. A notable slice of this is can be attributed to the OBR's estimate that Brexit added £59bn to UK borrowing to 2022, or nearly £200mn a week. These numbers include Phillip Hammond's sensible but small measures. Our UK economist is more pessimistic forecasting 0.9% in 2017 and 0.7% in 2018. Even if we split the two, that represents a 50% decline in expected 2017 gdp and 40% decline in 2018. The OBR also expects public sector net debt to hit its highest level since 1964-65 in 2017-18 at a time when the UK already relies on "the kindness of strangers" to finance its growing twin deficit.

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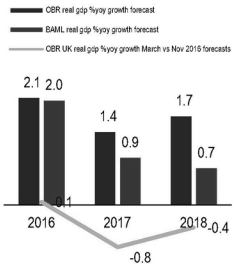
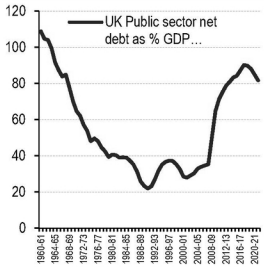
Chart 55: OBR / BofAML UK GDP forecasts materially lower in 2017



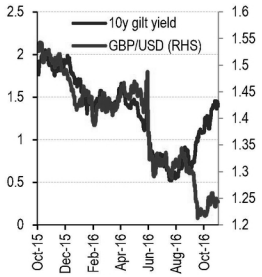
Source: BofA Merrill Lynch Global Research, Office of Budgetary Responsibility

Chart 56: UK Public sector net debt is expected to return to 1960s levels



Source: Office of Budgetary Responsibility

Chart 57: The weaker econ outlook has helped decouple GBP and gilts since late Sept'16



Source: Bloomberg

Certainty that Brexit negotiations will start, but uncertainty on the details

Against this debt and growth backdrop, investors are likely to want clarity and visibility on policymaking in order to continue funding the UK's deficit in our view. We think they could be disappointed.

Firstly, the Government has committed to triggering Article 50 by the end of March 2017. We think this is likely irrespective of the outcome of the Judicial Review on where the legislative power lies for making that decision. Second, the Government's formal position is not to announce its negotiating strategy in public. A lack of insight into the UK's future trading relationship with its biggest export market for goods and services is a difficult backdrop upon which to continue investing in the UK, even if a few companies have taken that decision already. Third, we think there will have to be a resolution to the trade-off between the Government's desire to control immigration and reach a beneficial economic settlement. The problem, as is often repeated by EU leaders, is that curbing migration puts the UK on a collision course with the EU's four freedoms and therefore at odds with access to the single market. That's why our base case remains a so called "hard Brexit", but even now our colleagues in FX strategy think investors are not positioned for this. Hence their GBP/USD forecast of 1.15 for Q1/Q2 2017.

Finally, a major concern for investors and especially business investment would be if the UK faces a "cliff edge" for trade terms in 2019 (on the assumption article 50 is triggered). While a transition deal would be a potential positive development next year, the absence of such a deal before or soon after article 50 is triggered could be another reason for policy uncertainty to spike higher again.

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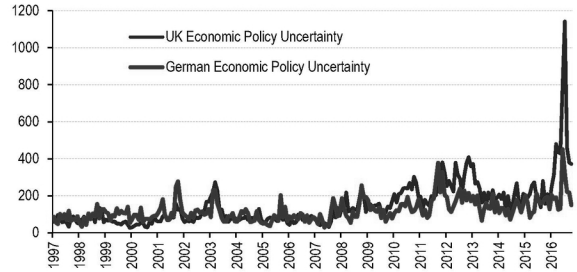
Chart 58: The dip in UK policy risk is likely to be short lived if the Govt keeps to its commitment to trigger A50 in Q1 without providing clarity on its negotiating position

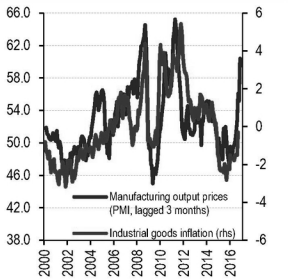


Source: Bloomberg

Building inflationary pressures point to post-Christmas consumer squeeze

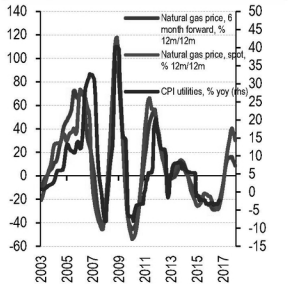
The third act in waiting for Brexit is cost-push inflation from the fall in GBP. So far, consumer spending has held up far better than most expected, especially retail spending by the over 50s. But there is evidence the inflationary canary is starting to sing. The charts below show that the move in CPI has lagged sharp rises in manufacturing output prices, utility prices and food prices in the past two months.

Chart 59: Firms report sharp increases in output prices



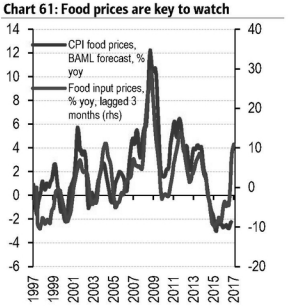
Source: BofA Merrill Lynch Global Research, Markit, ONS.

Chart 60: Chunky utility price increases on the horizon



Source: BofA Merrill Lynch Global Research, ONS, Bloomberg

Chart 61: Food prices are key to watch



Food input prices calculated as an average of domestically produced and imported food. BofA Merrill Lynch Global Research, ONS.

To understand this delay it is worth remembering "Marmitegate" and the pressure put on companies not to raise the prices of household brands. The incident also illustrates the margin pressure building up in the system and challenges posed to producers, vendors and consumers as to who will absorb the higher costs. According to the Chairman of the UK Food and Drink Federation many companies may be waiting until post-Christmas to change prices, which Ian Wright estimates could rise as much as 8%. If that happens at the same time as power prices hit seasonal highs, the consumer could start to feel the pinch.

To avoid this leading to a contraction in demand, workers we would need to see strong nominal wage growth. However, the Institute of Fiscal Studies does not expect real wages to return to 2008 levels until 2021. The tightness of the UK labour market could also cushion any blow, but we note jobless claims have started to rise again and businesses may be less likely to hire if uncertainty, for reasons outlined above, picks up again.

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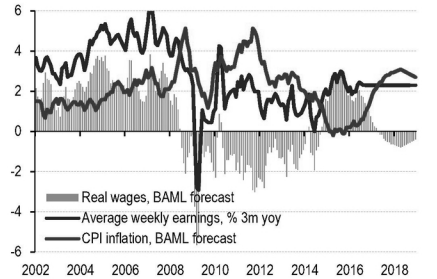
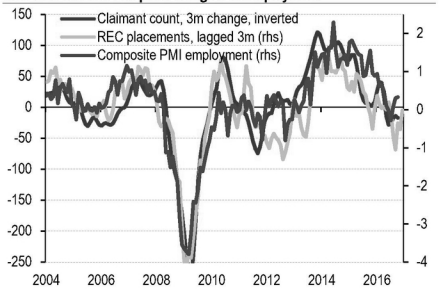
Chart 62: Real wages likely to fall



Real wages calculated as average weekly earnings minus CPI inflationSource: BofA Merrill Lynch Global Research, ONS.

Chart 63: REC and PMI point to higher unemployment



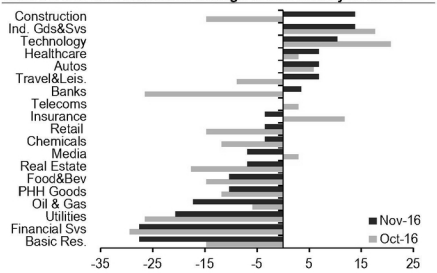
REC placements is an average of permanent and temporary placements. REC and PMI shown as standard deviations from average. Source: BofA Merrill Lynch Global Research, Markit.

Given all of the above, we reiterate our preference for avoiding sectors with a high proportion of domestic UK companies. To our mind, these companies face a lose-lose trade-off of maintaining margins by passing on higher costs at the expense of volumes, or face margin pressure by absorbing these costs in order to sustain current volumes in our view. This could be further compounded if our Oil Strategists' forecasts are right and Brent averages ~$60/bb following an OPEC cut.

But how much is in the price?

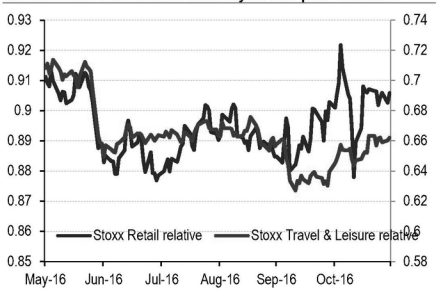
The pushback to our view is that the forecasted deterioration in growth hasn't really materialised and investors are already pricing it in a lot of bad news. For instance, Easyjet is down nearly 35% and investors are still underweight the UK in the FMS. While this is the case for certain stocks, at a sector level investors appear to have squared off their underweights in Retail/ Travel according to the FMS. Both sectors also back near pre-Brexit levels relative to the market (albeit Travel reflects the recent oil price weakness).

Chart 64: Source: Brexit sectors no longer underowned by investors



Source: BofA Merrill Lynch Global Research

Chart 65: Retail and Travel are some way off their post-Brexit lows



Source: Bloomberg

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Sector Trades

Table 7: European Sectors – Summary of investment case and risks

Sector (Ticker)	Index Weight %	Stance	Delta (bp)	Summary of view
HealthCare (SXDP Index)	**12.5**	**O/W**	**+150**	Laggard despite Republican clean sweep reducing legislative risks, valuations close to 2010-12 lows at trough of patent cliff but sector team expect 11% EPS CAGR 2018-2021 supporting 17/18x PE (currently on 13x 2018), catalysts from new products set to be announced in 2017. **Risks: rising bond yields continues, pipelines fail to realise, strong growth leads to risk-on rally led by value/ rotation out of quality.**
Oil & Gas (SXEP Index)	**4.6**	**O/W**	**-150**	Forecast Brent to average ~$61/bbl in 2017 on supportive demand backdrop (EM), OPEC reduction, supply destruction causing rebalance Oil team modeling 8%-17% upside from crude rally meaning FCF covers ~6% DY and EPS to improve (revisions 2nd best in market) **Risks: OPEC fails to cut supply pushing rebalancing out, strong dollar and protectionism curtail global demand and EM growth.**
Media (SXMP Index)	**2.6**	**O/W**	**+100**	Market laggard and de-rated presenting favourable entry points, optionality to improving EU consumer confidence even if UK consumer set to be squeezed next year, historically outperforms when dollar/ PMIs/ inflation rising, positioning now underweight in FMS. **Risks: UK growth/ EU consumer confidence drop quickly, investors prefer cheaper cyclicals if we see another leg to risk-on rally.**
Utilities (SX6P Index)	**3.9**	**O/W**	**+100**	Big underperformer in reflation rotation given defensive yield characteristics now oversold, consistent underweight in FMS but fundamental outlook positive with cyclical/ earnings improvement from higher power prices/ CSPP/ changing sector composition. **Risks: lack of differentiation from investors in rising yields continues, commodity prices roll, regulatory risk increases.**
Autos & Parts (SXAP Index)	**3.2**	**M/W**	**0**	Bull case: Margins supported by strong EU/ China sales, lease growth in US, valuations at multi-year lows, positioning neutral, cyclical beta Bear case: Future car raises questions over terminal value, US/UK markets peaked, Truck market has turned, China tax cut to end
Banks (SX7P Index)	12.4	M/W	0	Bull case: global yields and inflation continue to rise as global growth pushes higher, Italian banks successfully recap and earnings improve. Bear case: LT profitability challenges persists (ECB monetary policy), UK large caps underperform, rates move unwinds.
Basic Resources (SXPP Index)	3	M/W	0	Bull case: Investors still u/w, Trump delivers on fiscal not trade, DXY capped so EM recovery / China cycle continues, higher metals lifts FCF. Bear case: Protectionism rises, China cycle slows, hawkish Fed hurts EM rally, metals prices fail to sustain recovery.
Chemicals (SX4P Index)	5	M/W	0	Bull case: Cheap on relative PE/ DY, M&A pick-up, cyclically geared to improving EM growth, higher quality characteristics vs other cyclicals. Bear case: OPEC deal fails hurting oil, industrial cycle potentially at risk from protectionism, margins unsustainable given at highest since 2004
Const & Mats (SXOP Index)	3	M/W	0	Bull case: geared to expected increase in fiscal spending (esp US), EU mfg and construction PMIs solid, US ISM / housing market strong Bear case: Most expensive sector on relative basis, re-rated on fiscal expectations but EPS hasn't followed, exposure to softening UK market
Fin Srvs (SXFP Index)	1.9	M/W	0	Bull case: High proportion of dollar earnings/ sterling reporters, geared to pick up stronger markets, potential M&A targets Bear case: less attractive valuations and not as levered into better growth/ rising bond yields than other financials (e.g. Banks).
Ind Gd&Svs (SXNP Index)	11.9	M/W	0	Bull case: US mfg ISM strong, EU OECD lead indicator improving, expect fiscal spending in US, high RoE and consistent earnings Bear case: valuations stretched on PBV, big outperformance driven by re-rating more than eps growth, Q3 earnings season has been weak.
Insurance (SXIP Index)	6.4	M/W	0	Bull case: beneficiary of rising yields, strong balance sheets, cheap on PBV/ PE and attractive, growing and covered DY. Positioning still light. Bear case: lower beta and longer cycle than Banks, vulnerable to any rally in bond prices from Italy risks, higher DY in more cyclical sectors.
Persnl & HHG (SXQP Index)	8.8	M/W	0	Bull case: luxury stocks delivering growth, tobacco structural outperformer, has de-rated following Brexit rally but earnings outlook decent. Bear case: margins at 10y peak, stiff competition from digital innovation, EM consumer demand volatile, vulnerable to rising rates.
Real Estate (SX86P Index)	1.9	M/W	0	Bull case: oversold on CTI, at 10y lows on relative PE and bottom quintile on PBV, UK market held up post-Brexit, yield attractive if bonds rally Bear case: positioning o/w vs history, REITs vulnerable to rising yields backdrop, rental yields under pressure fall if UK/ EU growth slumps.
Telecomm (SXKP Index)	3.8	M/W	0	Bull case: strong FCFY and improving balance sheets, valuations not expensive, positioning has unwound, beneficiary of CSPP, major laggard. Bear case: structural challenges to monetising data, consolidation not set to play out, vulnerable to further outflows in rising yield environment.
Technology (SX8P Index)	4.1	M/W	0	Bull case: valuations less stretched, semis cycle proving resilient, higher "quality" cyclical, positioning neutral, structural growth Bear case: vulnerable to rotation into value sectors in a risk-on market, margins close to peak, structural challenges for Nokia/ Ericsson.
Food & Bev (SX3P Index)	**5.9**	**U/W**	**-150**	Highest correlation to rising yields/ bond proxy, valuations still not cheap on a range of metrics (esp vs Healthcare), falling earnings revisions. **Risks: Oversold vs history in rotation move, sector has de-rated enough if bond yields capped/ CB don't hike/ growth disappoints.**
Travel & Leisr (SXTP Index)	**1.8**	**U/W**	**-150**	Airlines in structural decline, negatively correlated to higher oil, vulnerable to weaker UK and returns at peaks levels, valuations not cheap **Risks: Oil rally takes longer to materialise if OPEC fails to cut, European/ global growth picks up and UK gdp surprises to upside.**
Retail (SXRP Index)	**3.1**	**U/W**	**-200**	Most vulnerable to consumer squeeze in UK, margins in structural decline, supermarkets have had their relief rally, expensive on PE/ PBV/DY **Risks: modest inflation provides pricing power, Eurozone growth boosts consumer demand, positioning light, strong x-mas season.**

Source: BofA Merrill Lynch Global Research

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Underweight Retail

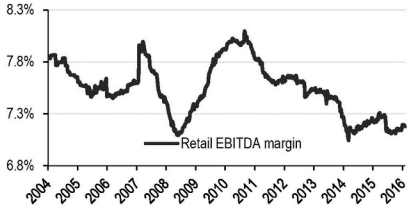
In addition to Brexit concerns, we also see a number of fundamental reasons to reiterate out underperform on Retail.

- **Structural margin pressures:** Aside from Brexit, retailers face declining returns as online disruptors and discounters drive up competition. EBITDA margins have fallen from 8% in 2010 to close to 7% in 2016 and RoE has declined by nearly 3% since 2004. We think this structural trend has further to run.

- **Valuations are also unattractive.** Retail remains on a significant premium to the market on absolute terms (17.3x 2017 PE vs 14.2x) and is expensive versus its own history at 20% above its 10y relative average on PE and 92%ile on PBV, while it has the second lowest dividend in the market (2.9%). Even if you strip H&M and Inditex the sector is towards the higher range of its post-GFC range.

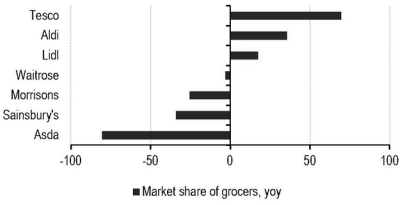
- **UK supermarkets have had their relief rally.** Despite challenges facing UK food retailers, Tesco has rallied 25% and Morrison's 15% since Brexit as retail spending has held up and the short base grew massively immediately following the UK-EU vote. Yet as Xavier Le Mene notes, this has largely been because they have gained market share from Asda and investors have bought into their new management plans. However, Xavier see limited upside potential for either next year and there is a risk that Asda starts to recoup lost ground under its new management too.

Chart 66: Stiff competition means retail margins are structural declining



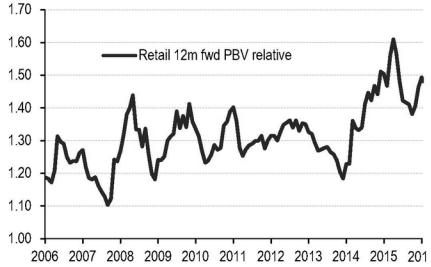
Source: BofA Merrill Lynch Global Research, Bloomberg, Datastream, IBES

Chart 67: Market share gains have largely been at Asda's expense



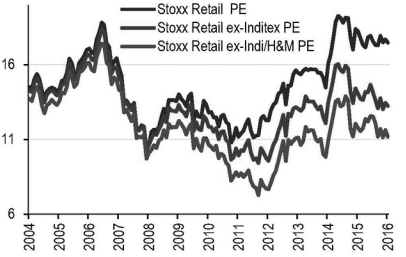
Source: Kantar Worldpanel

Chart 68: Retail is expensive on a range of metrics



Source: BofA Merrill Lynch Global Research, Bloomberg, Datastream, IBES

Chart 69: Not cheap even if you strip out the two biggest ex-UK names



Source: BofA Merrill Lynch Global Research, Datastream

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Underweight Travel & Leisure

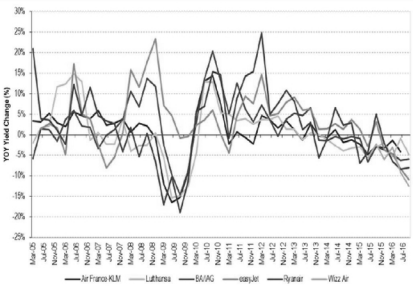
- **Airlines in structural decline:** our European Airlines analyst thinks overcapacity (networks set to grow 7% yoy to 2020) and competition from low cost/ ME carriers is driving prices and passenger yields lower across the board.

- **Negatively correlated to Oil:** the sector is negatively correlated to the Oil price and despite recent weakness, our Commodity Strategist expects OPEC to cut by 500k b/d or 1 million b/d. Should OPEC cut with firm quotas and a tight control mechanism, they see WTI prices averaging $59/bbl.

- **Watch UK consumer confidence closely:** the combined effect of the challenges we identified earlier starting to mount for the UK consumer and the drop in the value of the pound could reduce demand for and expenditure on overseas holidays. This would weigh on the travel operator part of the sector. If the bulk of sterling move is over the boost for dollar earnings like Compass will also likely fade.

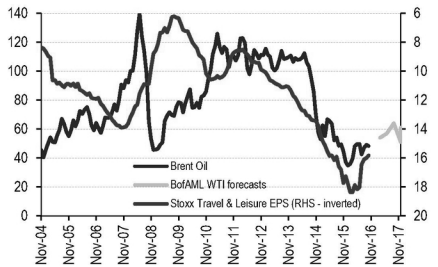
- **Peak returns:** unlike Retail, T&L margins (98%ile since 2004) and RoEs (85%ile) are close to all-time highs. We think returns may well have peaked therefore given the backdrop of rising oil, weakening consumer confidence in the UK and structural overcapacity in airlines. This is reflected in the fact that PBV are on 2.8x for the sector, which is top quintile for the sector since 2004.

Chart 70: Competition & overcapacity pushing airline yields down



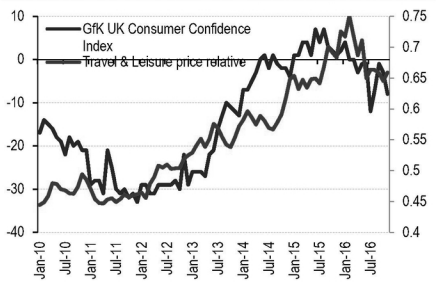
Source: Company data

Chart 71: Rising oil would weigh on Travel earnings



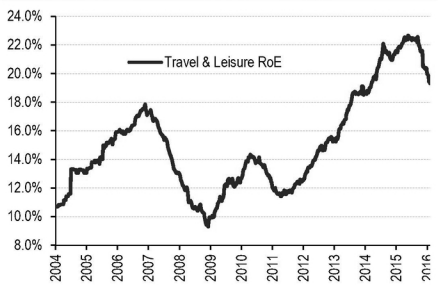
Source: BofA Merrill Lynch Global Research, Bloomberg, Datastream, IBES

Chart 72: The UK consumer will have lower purchasing power next year



Source: Bloomberg

Chart 73: Yet sector RoEs remain close to all-time highs



Source: BofA Merrill Lynch Global Research, Datastream, IBES

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Media – raise to overweight

Favourable entry point

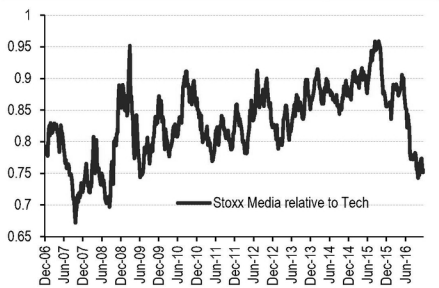
Media has been is a big laggard following a six-month period of sustained underperformance and hit very oversold levels on our CTIs in mid-November. Although Media is a bit more domestic than Tech both are "quality" cyclicals and typically trade fairly in line with one another. However, the relative is now back at 2009 lows.

Optionality on European consumer

We are bearish on the outlook for the UK consumer but consumer confidence has been steadily rising in the Eurozone since 2012 and the sector has tracked this measure very closely. We note however that the two have disconnected recently. We think Media is more likely to catch up then confidence fall given economists' fairly positive view on Eurozone growth next year, and the potential for upside surprises to US growth.

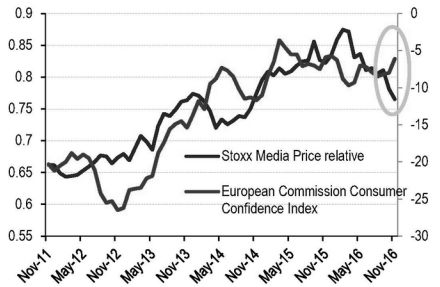
Chart 74: Favourable entry point for Media

Media and Tech are both "quality" cyclicals but the relative is at a 7y low



Source: Bloomberg

Chart 75: The pick-up in EU Consumer Confidence should boost Media



Source: Bloomberg

Media historically outperforms when PMIs and inflation rising

The average return for Media when PMIs and inflation are both rising is 0.6% relative but the sector has underperformed by 2% month to date. A stronger dollar is also a positive historically for Media given that many large caps within the sector, notably agencies, are large dollar earners. But again, the two have disconnected recently.

Valuations now at a small discount to the market

Media has de-rated by nearly four PE points (from 19.7 to 16) since the April 2015 highs and the sector now trades on a 5% discount to its average vs the market. We think the improving global growth backdrop will support earnings and should mean the sector can re-rate.

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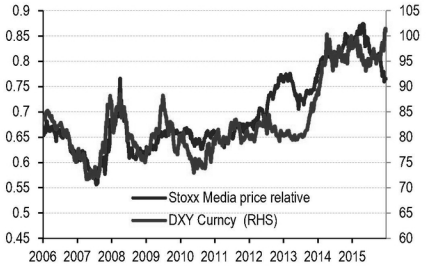
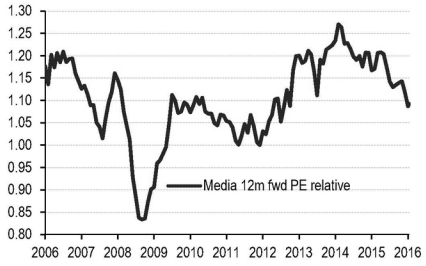
Chart 76: A stronger dollar benefits agencies with global exposure



Source: Bloomberg

Chart 77: Media now at a small discount to its 10y average vs market



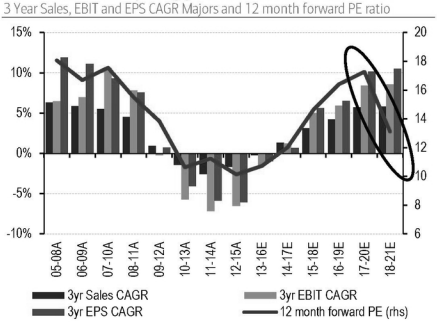
Source: BofA Merrill Lynch Global Research, Bloomberg, Datastream, IBES

Overweight Healthcare

Healthcare looks very attractively valued and we see compelling risk reward in the sector on an outright basis at current levels. The fundamental bull case for Health rests on the strong pipeline of new products for the big cap pharma universe. Our sector analysts forecast EU Pharma to deliver a 2018-21E EPS CAGR of 11%, up from mid-single digit levels in recent years. Historically that would justify a PE re-rating and a multiple for the pharma sub-sector nearer 17-18x than the current 13x 2018 PE.

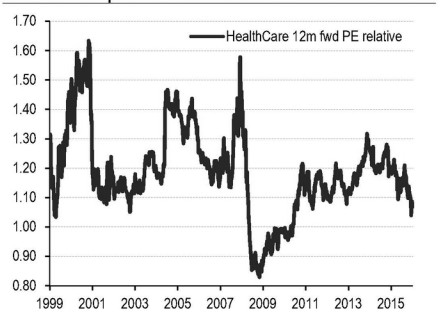
We believe the Republican clean sweep in the US elections represents a positive catalyst as it significantly decreases the potential for legislative initiatives to aggressively control drug pricing in the US. The catalyst for the sector to re-rate will come progressively from newsflow around new products. The next 12 months should see progress on this front with several of the European large caps expected to announce key data on important drugs in 2017.

Chart 78: Pharma's improving growth outlook not reflected in PE
3 Year Sales, EBIT and EPS CAGR Majors and 12 month forward PE ratio



Source: BofA Merrill Lynch Global Research

Chart 79: Healthcare PE relative back near market multiple and lowest since 2011 when patent cliff was at its worst



Source: BofA Merrill Lynch Global Research, Datastream, IBES, Bloomberg

Healthcare's forward PE is now down to just a 7% premium relative to the market and nearing the valuation lows recorded in 2010-12 when the patent cliff was at its worst and pipelines were very weak. Today pipelines are twice the size they were in 2011 and innovation is the key to growth in the sector - pricing power remains strong in drug categories with differentiated products. The new product launches expected between 2015 and 2018 add up to potential sales of $133 billion.

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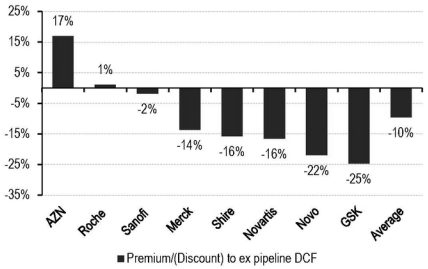
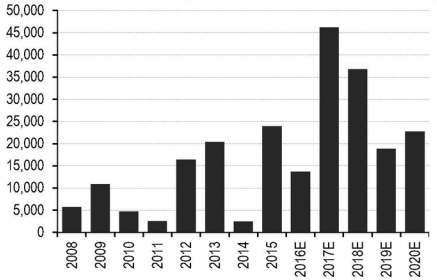
Chart 80: Stocks mostly trade above ex-pipeline value
Pipelines are free for most stocks



Source: BofA Merrill Lynch Global Research

Chart 81: Growth from new products - $138bn launching 16-20E Peak unrisk-adjusted sales potential (USDm) of product launchs by year



Source: BofA Merrill Lynch Global Research

Overweight Utilities

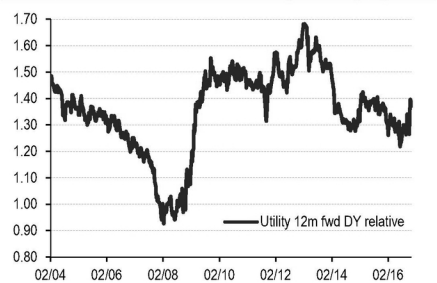
The Utilities sector has suffered badly from the back up in bond yields. However, fundamentals for the sector are actually improving relative to recent history. The sector is the biggest direct beneficiary of corporate QE in the UK and Euro are (more than half of the sector are eligible for the ECB's Corporate Sector Purchase Program) meaning it can gain more than most other sectors from potential refinancing savings. This cushions any effect on debt costs from higher bond yields as corporate bond yields are still very low.

Earnings and cash flow are improving. The bottoming out of the commodity cycle has supported a turn to the upside for power prices. This has helped earning to trough and analyst revisions have been positive throughout the last few months of underperformance. Balance sheets and dividends in most cases now also look sustainable. Valuation multiples for the Utilities sector are attractive relative to history and compared to other Defensives. EV/EBITDA for the sector sits at 7.3x on Bloomberg estimates. That is a 20% discount to the market and is near 10-year lows on a relative basis. With dividends more secure the relative DY becomes more attractive at 2-year highs.

Chart 82: Utilities EV / EBITDA relative to market near10-year lows

Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 83: DPS more secure now but the relative yield is at 2yr highs



Source: BofA Merrill Lynch Global Research, Datastream, IBES

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Investment rating	Total return expectation (within 12-month period of date of initial rating)	Ratings dispersion guidelines for coverage cluster*
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Neutral	≥ 0%	≤ 30%
Underperform	N/A	≥ 20%

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V.I. businesses face higher unemployment taxes as territory struggles to pay down $69 million debt

By BRIAN O'CONNOR
Daily News Staff

Territory business owners will pay four times the normal federal unemployment tax rate this year because of an unpaid government debt, documents show.

The federal unemployment insurance tax rate is traditionally 6 percent on the first $7,000 an employee makes. However, the federal government usually offers a credit of 5.4 percent, meaning most employers actually pay about 0.6 percent, according to the IRS.

States — and territories — with unemployment insurance programs meeting federal standards are required to meet their unemployment obligations. When a state can't meet its unemployment obligations, it's entitled to take loans from the Federal Unemployment Insurance Trust Fund.

Federal documents show only one state and one jurisdiction — California and the U.S. Virgin Islands — are currently in that position.

The territory owes $69,138,266.61 in loans, according to the U.S. Department of Treasury website.

In fiscal year 2017, which began Oct. 1, the loans have accrued $294,349.15 in interest payments alone.

The V.I. Labor Department is in charge of administering unemployment insurance. Labor Commissioner Catherine Hendry did not return a number of phone calls seeking comment.

Government House spokeswoman Cherie Munchez would not comment, saying that Hendry would issue a prepared statement about the debt by Wednesday.

Provisions of the Federal Unemployment Tax Act stipulate that in states or territories with outstanding balances in the fund, businesses are subject to a credit reduction, which is collected and directed toward the unpaid balance, according to Robert Pavosevich, Supervisor of the Actuarial Team in the Office of Unemployment Insurance's Division of Fiscal and Actuarial Services in the Department of Labor.

Virgin Islands business owners will pay the original 0.6 percent, plus an additional 1.8 percent caused by the unpaid balance, for a total of 2.4 percent, Pavosevich said.

At the fully discounted rate, an employer would pay $42 for each employee earning $7,000. At the Virgin Islands rate, employers will have to pay $168.

After two years with an unpaid balance, the discount decreases by 0.3 percent each year until the total discount disappears, Pavosevich said.

"It's capped at 6 percent," Pavosevich said.

At the full 6 percent, employers will have to pay $420 for each new employee earning $7,000 that comes on board. By law, that money can't come out of the wages themselves and is paid out of the profits or losses that employers face, said Charles Engeman, an attorney who served on the Unemployment Insurance Advisory Council under the administration of Gov. John deJongh Jr.

Without payment on the loan — or waivers or relief, which has happened three times since 2013 — the rate is scheduled to max out by 2028. That's barring the imposition of step increases, which can happen if the state has an outstanding balance for a certain number of years, or if — as was the case in the tax year 2012 — step increases are piled on by other provisions of the law, which could move the unemployment tax rate up faster.

"It looks like they're not making much headway," Pavosevich said, referring to the territory's debt.

The territory wasn't alone in 2011, the first year the rate went up. In all, 20 states and the Virgin Islands received a 0.3 percent credit reduction that year, federal documents show.

That's in part because of the lingering effects of the Great Recession, said Bennett Chan, a lawyer who represents several businesses and has worked with the St. Thomas-St. John Chamber of Commerce in the past.

> **I don't think there's enough political willpower to do the kinds of thing necessary to fix the system.**
>
> — Charles Engeman, an attorney who served on the Unemployment Insurance Advisory Council under the administration of Gov. John deJongh Jr.

> **The business owners always bear the brunt of whatever deficiencies we have. We have to, at some point, find other sources of revenue for the government. Any time there's any sort of additional tax burden, fee burden, licensing burden, it's always a point of concern.**
>
> — Kimberly McCollum, president of the St. Croix Chamber of Commerce

In general terms, states collected more money than they paid out during the years leading up to the 2008 market collapse, creating large surpluses. Sometimes those surpluses were subject to financial raids. Other times — as was the case in the territory — the surpluses were used as a cause to reduce the amounts collected for unemployment insurance. When large-scale unemployment hit as a result of the recession, surpluses turned into deficits, Chan said.

"A lot of states were blindsided by the Great Recession," Chan said. "They also had big surpluses and never foresaw that there would be this sudden inflow in unemployment claims."

Territorial officials were late in reacting to bring the rate back up to address the issue, Chan said.

"If we had done it earlier, we probably would have collected enough," he said. "Now they want to make it up when times are hard."

In many cases, the government can't say what each employer owes or has paid in surplus, Engeman said.

The system originally was set up so that employers faced a roller coaster, Engeman said.

Each employer had a rate based on a three-year average. If an employer's account paid out more in benefits than they contributed, the rate would go up to 5.4 percent. After three years, the employer's rate would drop down to 0.1 percent, because at 5.4 percent, the rate exceeded likely contributions.

At 0.1 percent, if anyone were laid off, it immediately moved the employer back to the 5.4 percent rate. Employers would oscillate between the 5.4 percent rate and the 0.1 percent rate.

"It was 5.4 for many employers, and that's what an average employer would pay out over the course of 17 years for one employee," Engeman said.

As a result, the unemployment insurance fund accumulated large surpluses. To reduce the surpluses, the V.I. Labor Department dropped the automatic increase based on a negative account, and lowered the minimum rate to 0. Less money came in, even as unemployment rates remained high and benefits remained expensive.

A few steps could help move the system back to sound footing, Engeman said. For example, better record-keeping would help reduce delinquencies. Reducing unemployment insurance benefits and reducing the amount of time the unemployed are eligible for unemployment would both help. Verifying that those collecting unemployment are seeking employment, and generally reducing fraud also would help, Engeman said.

"I don't think there's enough political willpower to do the kinds of thing necessary to fix the system," he said.

Chamber of Commerce officials on both islands decried any increase in taxes or fees for businesses.

"Despite what the governor and the senators think, the economy of the Virgin Islands is not doing that well," said Tom Brunt III, a member of the St. Thomas-St. John Chamber of Commerce Board of Directors.

Kimberly McCollum, president of the St. Croix Chamber of Commerce, said any increases to fees or taxes was worrying.

"The business owners always bear the brunt of whatever deficiencies we have," she said. "We have to, at some point, find other sources of revenue for the government. Any time there's any sort of additional tax burden, fee burden, licensing burden, it's always a point of concern."

The folly of the situation is compounded by the fact that business owners themselves aren't allowed to file for unemployment if they lose their jobs, McCollum said.

"You're still paying unemployment taxes on what you're paid, but you are not allowed to request compensation should you find yourself in a position to file for unemployment," she said.

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Work stoppage threat gets Waste Management to table

By JONATHAN AUSTIN
Daily News Staff

A Waste Management Authority contractor had planned a work stoppage this week because the Virgin Islands Waste Management Authority owes vendors a lot of money and they can't keep working for nothing.

However, discussions with administrators at Waste Management led Peter Caproni, owner of Your Environmental Services Inc., to say he's holding off on urging garbage collection vendors to stop work on Wednesday.

"I'm not intent on messing up our communities," said Caproni, whose company picks up the bin sites on St. John.

"We've created a dialogue. I am a fair person," Caproni said. "I want to listen to what they have to say. It seems as though they're going to put together an offer."

Caproni had told The Daily News on Monday he was announcing a work stoppage beginning Wednesday. He said he and other haulers were going to stop emptying scores of bins across St. Thomas and St. John because Waste Management had failed to pay them for weeks or months.

Caproni said he has worked 26 years in trash removal and roll on/roll off services in the territory. He said his company empties "all the rear load bins on St. John," and does emergency Waste Management Authority work on St. Thomas.

Contacted by The Daily News, Waste Management Authority executives were unaware Caproni and possibly two other haulers were walking off the job.

Roger Merritt Jr., the newly hired executive director of the agency, said Monday evening he wants to meet with all the contracted haulers to see what they are owed and come up with a plan to get them paid.

"I understand that the haulers need to get paid," Merritt said. "We need to ensure we are able to make timely payments."

Caproni said he is willing to listen, but the answer has to be that the Waste Management Authority comes up with payment for services already rendered.

"The solution is, you pay your bills on time," he said.

Patrick Charles, one of the vendors Caproni mentioned, said Monday that he has "reasons to be on board" with a work stoppage, though he couldn't make such a decision alone.

"I realize that he is upset," Charles said, referring to Caproni. "It is time for anybody to get upset. I'm in agreement with him."

> **The solution is, you pay your bills on time.**
>
> — Peter Caproni, owner of Your Environmental Services Inc.

Charles said his firm empties bins on St. Thomas and hauls trash from Waste Management Authority collection sites in a number of government housing communities.

Regarding how much Waste Management owes him, Charles replied: "It depends on what you call a lot. They're two months behind, now."

Caproni wouldn't say how much Waste Management owes him in total.

"It's a big amount of money," he said. "I'm fed up with the whole thing."

Caproni said he estimated that Waste Management owes various vendors millions of dollars.

The Waste Management Authority's inability to pay vendors has been a topic during Senate testimony over the years.

Steve Aubin, who was interim executive director of the Waste Management Authority for most of 2016, told the Senate Finance Committee in July that the contractors needed to be paid.

"It is clear that the contractors are bearing the brunt while trying to provide critical services in hopes of payment by the authority as soon as possible," he said.

Aubin ran the agency after the retirement of May Adams Cornwall until Merritt was hired last month.

"The financial condition of the Virgin Islands Waste Management Authority is dire and requires immediate attention and relief," Aubin told senators in July. "The authority's available cash to pay its contractors/vendors timely is critically limited, resulting in delayed payments to its contractors/vendors; growing accounts payable, which is currently on the order of $10 million for its major contractors/vendors; and non-compliance at the Anguilla and Bovoni landfills with court ordered mandates."

An example of the outstanding obligations owed by Waste Management has been highlighted for the last two years in Senate testimony during the budget process. For Fiscal Year 2016, the agency noted it owed vendor Gem's Construction $200,000 from fiscal year 2012 to pay for garbage collection services on the island of St. Thomas.

The Waste Management Authority noted that it was "unable to identify a revenue source" to pay Gem's for the years-old debt.

During testimony on the Fiscal Year 2017 budget, Waste Management again listed $200,000 owed to Gem's Construction for garbage collection on St. Thomas. However, Waste Management officials said the $200,000 was owed from the 2011 fiscal year.

No one from Gem's Construction was available for comment Monday afternoon.

Merritt said he believes the Waste Management Authority can address the overdue debt owed to the vendors.

"I think we can. We've got to get a plan in hand and get them paid. If they provide a service, they should get paid," he said.

— Contact Jonathan Austin at 340-714-9104 or email jaustin@dailynews.vi.

Police: Ex-employee filing 'frivolous' complaints against top cops

By BRIAN O'CONNOR
Daily News Staff

Police officials dismissed this week multiple complaints filed by a former employee against high-ranking members of the VI. Police Department.

The complaints are all filed by Lynne Harrison, the former director of the Police Training Bureau.

In one such complaint, Harrison alleges Deputy Commissioner Curtis Griffin Jr. was "receiving compensation when absence from employment without proper leave documentation," and "payroll fraud/embezzlement — falsifying timekeeping records, or when employees are not working while on the job."

In a letter attached to the claim, Harrison says that from August 2016 to the present, Griffin received compensation while not reporting for duty at the department.

"In addition, he has not left forwarding contact information to those under his supervision and often was not available during contact attempts occurring during normal working hours," Harrison wrote. "Griffin was available only via VIPD email which was delayed or not deliverable, thus leaving him ineffective and not suitable to be classified as working telecommuting."

Griffin dismissed the complaints against him, and said he welcomed an investigation.

"I want them to investigate because I'm hoping — when all is done — I'm hoping that maybe I can sue her for slander," he said. "I have nothing to hide."

Harrison's letter calls for Griffin to be investigated.

"While his explanation of absence has been reported as a long term medical procedure, due to the extraordinary length of absence, previous absences, and non-contact information, a full investigation is warranted to insure the people of the Virgin Islands have not been deprived of its funds due to improper payroll deductions or notifications," she wrote.

The complaint was one of 10 filed after Harrison lost her job as director of the police department's Training Bureau, according to copies furnished by Harrison.

She filed a citizen's complaint after her termination alleging that Police Commissioner Delroy Richards Sr. had violated department policy and that he had ignored requests for the correction of a violation.

Harrison also filed a complaint alleging Griffin's administrative assistant, Le-Reeda Lake, was absent on sick leave for four weeks without prior notice; that special assistant to the commissioner Capt. Mary Duggan had potentially disclosed confidential department information to a third-party vendor for personal gain, and had used threatening behavior to create a hostile work environment, and that she had obstructed Harrison's performance of her duties.

Harrison further alleged that Lt. Maria Colon-Jones had disrupted a training presentation, and she said her termination was retaliatory for asking for sick leave to be treated for Zika.

Harrison said that she eventually fled the Virgin Islands in fear of her life and that the police department still owes her $5,000 in back pay, Harrison said.

Harrison said Monday she's submitted her complaints to Gov. Kenneth Mapp.

"I was the director of training and was fired without cause," she said. "I had filed several complaints."

Harrison said she requested 10 days of medical treatment off-island to combat a Zika infection on Oct. 18.

"Two hours later, I was terminated," she said.

Documents provided by Harrison show she was suspended without pay on Oct. 18, and terminated on Oct. 28.

Griffin said that while he was undergoing cardio rehab in Florida, he started hearing about issues involving Harrison. Ultimately, Richards made the decision to terminate Harrison, Griffin said.

"Subsequent to her termination, she started sending complaints," he said. "She said she heard that while I was away I was practicing law and not really sick."

Harrison wasn't his supervisor, and wasn't aware of how the accumulated sick time was being used, Griffin said.

"She submitted so many complaints against so many people," he said. "It's obvious that it's frivolous."

The complaints have not yet resulted in an internal investigation, Richards said.

"I found she was too much of a distraction for us to move forward with the actions as required of us by the mandates of our consent decree," Richards said about his decision to terminate Harrison.

Harrison had failed to submit to a department background check in a timely manner, Richards said.

"The department brought her in on an interim basis initially, and then she was asked to comply with the package that we provided in order to conduct a background investigation," he said. "She offered resistance. She believed she could complete her own timeline."

Harrison said she had asked for 10 days to secure her college transcripts.

"My email specifically says I am not saying I don't want a background check," she said.

Richards said he ultimately directed Harrison's complaints to the legal department, but he said Harrison continued to send letters and emails.

A response from the department's legal counsel provided by Harrison says simply that Harrison couldn't use the citizen's complaint process to complain about things that happened while she was the director of the Training Bureau, and that each complaint will be closed as it is received.

"In some of her letters and emails, she appeared very threatening," Richards said. "In one of her emails she wrote 'You are sicker than a tree branch that's going to be cut down very soon.' It's one ignorance after another."

Harrison disputes that characterization.

"I'm very professional," she said.

Griffin was on legitimate sick leave when he was in Florida, Richards said.

"He was being treated and he entered into a program in Florida," he said. "The woman is on a witch hunt all over."

— Contact Brian O'Connor at 340-714-9130 or email boconnor@dailynews.vi.

HOUSE_OVERSIGHT_014500

Police say woman tried to smuggle pot into prison

By BRIAN O'CONNOR
Daily News Staff

A Mon Bijou woman tried to sneak two bags of marijuana into Golden Grove, police said.

Sherifa Petersen, 27, faces a single charge of introducing contraband into prison, and was free on $10,000 bail about six hours later, according to her arrest record.

V.I. police arrested Petersen on Friday afternoon about 1:47 p.m., after corrections officers discovered the marijuana hidden in the personal belongings of inmate Omari Gordon, according to Petersen's arrest log.

Rick Mullgrav, Director of the Bureau of Corrections, said corrections officers discovered the marijuana during a routine search.

Petersen "was bringing a package for her companion, and I will say her companion, because I'm not sure what the relationship was there," Mullgrav said. "She was coming to visit, and she brought some drugs."

Corrections officers told police they had smelled marijuana in a pair of black Jordan sneakers Petersen was bringing to Gordon, according to a VIPD press release. When corrections officers pulled apart the sneakers, they discovered two small plastic bags of marijuana, according to the press release.

Any material that ends up in the hands of prisoners is thoroughly searched as a matter of routine, Mullgrav said.

"We search any item that goes to the inmates," he said. "Generally speaking, it's pretty thorough."

Gordon, 32, has been in jail since police charged him with first-degree attempted murder and first-degree assault following a Nov. 29 shooting on St. Croix, authorities have said.

Gordon's name also matches that of a man charged in 2010 with the murder of 19-year-old Kendal Wood. Gordon's trial languished in the Superior Court on St. Croix for almost three years, and he was most recently granted a continuance in 2013.

The disposition of the murder case involving Gordon couldn't be immediately ascertained Monday evening.

Gordon had been released on electronic monitoring and house arrest pending trial in 2013, according to court documents at the time.

He was being held on $500,000 bail in his most recent arrest, police said.

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Federal judges from Philadelphia in the Virgin Islands to hear cases

By BRIAN O'CONNOR
Daily News Staff

The 3rd U.S. Circuit Court of Appeals will sit this week in the federal courthouse on St. Thomas.

Judges Kent Jordan, Michael Chagares and Thomas Hardiman will hear a range of appellate cases, ranging from a local prisoner challenging his detention as unconstitutional to an estate battle over an inheritance in which two separate federal cases were merged into one.

The judges fly in from Philadelphia to hear argument on issues they decide at a later date.

Appellate court argument is based around rapid-fire questions from the empaneled judges, unlike civil or criminal court, which frequently is dominated by long exchanges between attorneys and witnesses.

The appellant attorney gets four minutes to make a case, followed by four minutes from the appellee, followed by four minutes of rebuttal from the appellant attorney, though judges' questions can sometimes turn four minutes into eight.

For example, Ronald Gillette, incarcerated in 2008 on multiple counts of aggravated rape and unlawful sexual contact against two children, is seeking an appeal on a motion denying his release from custody.

Gillette's attorney, Joseph DiRuzzo III, began on Monday by making his case that the motion, ordered by Chief District Court Judge Wilma Lewis, constituted a final judgement and thus was worthy of an appeal. DiRuzzo sought a three-judge panel to overturn Lewis's order.

It didn't take long for Jordan to ask a question.

"How can it be a final order if there are still claims in the case, if you're still seeking relief, which you are?" he said.

DiRuzzo had a response.

"The denial of a three-judge panel effectively throws Mr. Gillette out of court," he said. He started to add to this, but Jordan cut him off.

"There are claims for relief, they still exist," he said. "I'm struggling to see how this is a final judgement."

Orders relating to the change in the reduction of a prison population essentially rely on three-judge panels to be valid, DiRuzzo said. Prison orders issued by a single judge are subject to challenge on appeal, DiRuzzo said.

"I would submit that three-judge courts are desirable in confrontations between state and federal power," he said.

Kimberly Salisbury was the Assistant Attorney General arguing for the appellee. Her job on Monday was to tell three federal judges that it wasn't their job to decide Gillette's case.

"This particular order is just simply not final," she said, at one point.

However, Hardiman had a question.

If there was an order short of Gillette's release that could make the prison resolve the Eighth Amendment violations that put the prison under a federal consent decree for decades to resolve, Lewis or another judge could still make the determination. The prison has completed only 14 percent of the new consent decree ordered in 2013 according to testimony.

"What would that order look like?" Hardiman asked.

Salisbury struggled with an answer.

Jordan tried to steer the argument back to the facts of the case.

"Does the fact that a 2013 consent decree superseded and replaced the original, does it mean the three decades of prior noncompliance is to be ignored?" he said. "You're not even a fifth of the way completed. At what point is enough enough?"

Complying with the consent decree will take time, Salisbury said.

"According to the Bureau of Corrections, we're not there yet," she said.

Chagares jumped in, and compared Golden Grove Adult Correctional Facility to a luxury cruise liner.

"It's like your big cruise ships out in the bay," he said. "It takes a long time to turn around. But this is a really long time."

Hearings will continue today before the Third Circuit at the DeLugo Federal Building on St. Thomas at 9 a.m. Another session is set for Thursday starting at 10:30 a.m.

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Evening
1st prize 7 5 8 0

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(Dec. 9) Next draw: Tonight
19 27 47 67 68
Mega Ball: 1

Powerball
(Dec. 10) Next draw: Wednesday
12 21 32 44 66
Powerball: 15

Mapp turns to new taxes in accepting court ruling on 8% government pay cut

By JONATHAN AUSTIN
Daily News Staff

Gov. Kenneth Mapp said Monday he believes the territory must accept a federal court ruling that found a 2011 government employee pay cut unconstitutional.

"After reviewing the case with the attorney general and reviewing the case with our financial team, I really am of the mind that the government of the Virgin Islands should make good on this claim," Mapp said.

He said he wants the Legislature to sign on to a plan to pay the claim and address other issues by approving increased sin taxes, taxes on time-share occupants, and changes that set a minimum tax for property owners who claim tax credits.

He said the lawsuit judgement is valued at $65 million.

"We will include all workers affected by the cut. In unions, all unions, and out of unions," Mapp said.

The territory had asked the full 3rd U.S. Circuit Court of Appeals to reconsider the judgement, which was penned by three of the court's judges.

The court rejected that request Monday.

The governor made his comments during a press conference Monday morning on St. Croix.

The conference originally had been scheduled for Friday on St. Thomas, but was delayed for no stated reason.

Mapp also announced he has invoked public exigency authority to fast track road repairs in the territory.

He described public exigency as "sort of a public emergency" declaration that should allow the government to more quickly award repair contracts for roadways that have deteriorated following extensive rainfall.

Mapp said he has consulted with federal authorities and hopes to access existing highway project funds "to use them to get the primary road system and secondary road system repaired."

He said the work will be done under existing federal road requirements, meaning they include proper drainage, sidewalks, striping and other elements, "all compliant with federal highway and DOT standards."

Regarding the 3rd Circuit ruling on the 8 percent cuts enacted through the V.I. Economic Stability Act of 2011, Mapp said the territory could pay off the amounts due to employees in two years if plaintiffs in the case give the government time to make good.

He said the payments can be satisfied if new tax collections from what he called the Virgin Islands Enhancement and Economic Recovery Act, which must be approved by the Senate, total at least $80 million.

He said alcohol and tobacco in the Virgin Islands is sorely undertaxed, and 40 million bottles of beer are sold each year in the territory.

Additional tax also would be charged on distilled alcohol and wine.

"In addition, we are seeking at least $12 per carton tax on cigarette and tobacco products in the territory," as well as "a sugar tax on carbonated sweet beverages," Mapp said.

Mapp suggested most of the millions of beers are consumed by tourists, so the tax would target visitors who enjoy the territory and should contribute to maintaining its infrastructure.

"If you felt that was too expensive, then stop drinking beer. That's healthy. That's a benefit," Mapp said, referring to locals who drink alcohol.

Mapp is also seeking a tax on time-share occupants, and wants to require that any resident claiming credits on property taxes pay a minimum annual property tax of $360.

He said the additional tax revenue could also provide $18 million to pay worker's compensation debts to medical providers, hospitals and injured workers in the territory.

Mapp said Monday that "as of today," he was not prepared to call the Legislature back into session to address his proposal.

Senate Majority Leader Sammuel Sanes said Monday he hopes more revenue could be generated through the reopening of the St. Croix oil refinery to pay some of what Mapp wants.

"We shouldn't rely so much on taxation. Right now, people of the Virgin Islands are facing a financial burden. Now we want to tax them more. That is not appealing to me at all," he said.

"There are some good points" to the governor's suggestions, Sanes said. "I see his point. I can understand where he is coming from," he said.

Lame duck Sen. Clifford Graham said Monday that the promise to repay government workers back for the pay cut won't be enough to convince legislators to support Mapp's proposal.

"The governor has sent us his version of the deficit reduction strategy," Graham said. There are parts that senators will support, and "some we definitely would not be in favor of," he said.

Graham said paying back the government employees should be a priority.

"Are they Number 1 on the priority list? I think there are more critical issues now," Graham said.

Graham said he is not sure whether the 31st Legislature will consider Mapp's approvals before it stands down this month.

"I am willing and able to work until my last day," he said. "I am not sure the calendar will afford us the time to do so."

— Contact Jonathan Austin at 340-714-9104 or email jaustin@dailynews.vi.

Senate Agenda

Today

The Homeland Security, Justice and Public Safety Committee will meet at 9 a.m. in the Lawaetz Conference Room on St. Croix to get an update on the V.I. Police Department, the V.I. Corrections Bureau and the V.I. Health Department.

Wednesday

The Finance Committee will meet at 9 a.m. in the Ottley Legislative Hall on St. Thomas to consider a bill relating to the International Banking Center Regulatory Act and a bill reappropriating $2 million of Luis Hospital appropriations for the use of the HVAC project.

Thursday

The Rules and Judiciary Committee will meet at 9 a.m. in Ottley Legislative Hall on St. Thomas to consider bills that include a bill to increase the Emergency Services Surcharge from $1 to $2; a bill providing for the disposition of proceeds from the rental or sale of housing units acquired in the Limetree Bay Terminals operating agreement to a bill regarding the establishment of credit unions and their oversight; and a bill creating the V.I. Risk-Based Capital for Insurers Act.

Friday

No meetings.

Governor's Agenda

Today

No appearances scheduled.

Government House did not provide Gov. Kenneth Mapp's agenda.

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She then traded the cold winters of Ann Arbor for the bright lights of New York City! She was a fellow of General Dentistry at the Columbia University School of Dental and Oral Surgery, for 2 years. It was her exposure there that led her to pursue a specialty degree in Pediatrics. She completed her Pediatric Dentistry Resi-dency at St. Barnabas Hospital- New York Presbyterian Weill Cor-nell, Bronx, New York. Her genuine love of children is evidenced by the arduous tasks she completed, to enable her to treat them ex-clusively. She likes practicing dentistry, but LOVES rendering care to children!

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Oswald Harris Court raid yields 2 marijuana arrests

By SUZANNE CARLSON
Daily News Staff

ST. THOMAS — A massive operation involving more than a dozen armed local and federal officers — while a helicopter circled overhead — at Oswald Harris Court on Friday evening yielded two marijuana arrests.

Jose Squiabro, 42, and Yasim Ross, 31, both of Oswald Harris Court, were arrested as a result of the operation, according to court documents. Both were charged with possession of marijuana with intent to distribute and released Monday after posting $10,000 bond each. Arraignment for the two men is scheduled for Jan. 5.

Friday's operation shut down the housing community and caused alarm for residents around Estate Thomas, Long Bay and Centerline Road.

More than a dozen armed officers secured the intersection around Building 9 in the housing community as a U.S. Customs and Border Protection helicopter flew overhead. None of the officers would say what they were doing, but they were dressed in tactical gear, some armed with long guns that appeared to be semi-automatic rifles, and officers wore body armor labeled as being from the Drug Enforcement Administration or police.

Probable cause affidavits filed Monday against Squiabro and Ross shed light on the operation, known as "December Reign."

The operation is a joint effort by officers from Homeland Security Investigations, U.S. Customs and Border Patrol, the Bureau of Alcohol, Tobacco, Firearms and Explosives, the Drug Enforcement Agency, the Justice Department, and the V.I. Police Department. It is meant to patrol St. Thomas housing communities, "due to the recent increase in gun violence in those areas," according to the affidavit for Ross.

At 4:45 p.m. Friday, officers approached a group of men around Building 20 and noticed Squiabro drop a partially smoked joint, according to the affidavit.

Officers recovered the joint and 105 bags containing marijuana, according to the affidavit. The affidavit does not note how large the bags were or the total weight of marijuana recovered.

Daily News file photo

A U.S. Customs and Border Protection helicopter circles Estate Thomas on Friday evening as police on the ground secured the intersection around Building 9 at Oswald Harris Court housing community on St. Thomas.

Officers also recovered $1,045 in cash and a Samsung cell phone from Ross, both of which were returned to him, according to the affidavit.

Squiabro's criminal history includes a 1993 arrest for second-degree burglary, which was dismissed in 1997; a 1996 arrest for possession of stolen property, for which he was sentenced to a $500 fine, one year in jail suspended after six months, and two years' probation; and a 2001 arrest for possession of an unlicensed firearm, for which there was "no known disposition" listed in court documents.

Similar to Squiabro's arrest, at about 5:50 p.m. Friday, officers approached Ross and other men near the 1st Stop Gas Station in Estate Thomas, which is located south of Oswald Harris Court. When asked whether he had any illegal substances, Ross said, "yeah I have a little weed in my back pocket," according to the affidavit.

Officers found a total of 2.2 ounces of marijuana packaged in various plastic bags in Ross' possession and arrested him, according to the affidavit.

Ross's criminal history includes a 2003 arrest for third-degree burglary; a June 2009 arrest for delaying and obstructing; a Sept. 2009 arrest for first-degree robbery, possession of a dangerous weapon, and unauthorized use of a vehicle; and he was arrested in January and charged with destruction of government property.

Court documents list "no known disposition" for each of Ross's prior arrests.

— Contact Suzanne Carlson at 340-714-9122 or email scarlson@dailynews.vi.

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Crack dealer arrested in Red Hook

By SUZANNE CARLSON
Daily News Staff

ST. THOMAS — Federal agents arrested a crack cocaine dealer in Red Hook on Saturday as part of an ongoing investigation targeting armed drug trafficking, according to court documents.

Tolomah Foy was arrested and charged with possession of crack cocaine with intent to distribute, according to an affidavit filed Monday by a special agent with the U.S. Bureau of Alcohol, Tobacco, Firearms and Explosives, also known as the ATF.

The arrest came as a result of operation "Total Recall," an ATF initiative on St. Thomas that began in August and is ongoing, according to the affidavit.

"This investigation focuses on the armed drug trafficking fueling violence which has resulted in over 48 homicides to date," according to the affidavit.

Agents focused on armed drug traffickers operating in Red Hook, a commercial bar and restaurant district frequented by a large number of tourists, and have created cases against 10 subjects for federal firearm and narcotics violations so far, according to the affidavit.

On Nov. 11, an undercover agent made a cold contact with Foy, also known as "T," who led the agent behind Tap and Still and sold him approximately 3 grams of crack cocaine, according to the affidavit.

The agent exchanged phone numbers with Foy and called him on Nov. 14 to arrange another transaction outside the Fresh Mart Grocery store.

Foy asked the agent to instead meet him behind Tap and Still, where he sold him approximately 6 grams of crack cocaine for $200, according to the affidavit. On Nov. 17, Foy sold the agent 9 grams of crack cocaine for $600 at the same location.

On Friday, the agent exchanged text messages with Foy and arranged for another transaction, and on Saturday, agents recorded a phone call with Foy in which he agreed to sell approximately $1,500 worth of crack cocaine, according to the affidavit.

The agent met with Foy at approximately 6:15 p.m. Saturday in the rear parking lot of Tap and Still, "consequently the ATF cover teams descended on scene and arrested Foy," according to the affidavit.

Agents retrieved 15 grams of crack cocaine from Foy on Saturday, and seized approximately a total of 32 grams of crack cocaine from Foy during the investigation, according to the affidavit.

— Contact Suzanne Carlson at 340-714-9122 or email scarlson@dailynews.vi.

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Man arrested in Arizona for armed jewelry store robbery

By SUZANNE CARLSON
Daily News Staff

Police have extradited a man from Arizona and charged him in connection with the 2013 armed robbery of Gems and Gold Corner, according to V.I. Police spokeswoman Sakeeda Freeman.

Ron Kuntz, 42, was arrested at 11:55 p.m. Saturday and charged with first-degree robbery, second-degree robbery, grand larceny, first-degree assault, third-degree assault, destruction of property, and aiding and abetting. Bail was set at $150,000.

Kuntz and others were identified as being responsible for the armed robbery in Drake's Passage on Sept. 16, 2013, Freeman said.

The robbery occurred just before 10 a.m. when a man entered the store and pulled a handgun from his waist, police said at the time. The robber told the owner, who was the only person in the store at the time, to get down and then broke out some of the glass cases in the store.

Police did not say what the value of the goods taken was.

Kuntz was apprehended and detained in Tempe, Ariz., after a routine traffic stop, and Arizona police discovered there was an outstanding warrant for Kuntz from the U.S. Virgin Islands, Freeman said.

Kuntz waived extradition and was returned to St. Thomas to face charges, Freeman said.

Freeman said Kuntz lives in Estate Tutu, but the V.I. Police arrest log listed his address as East Baseline Road in Phoenix, Ariz.

Anyone with information about crime in the territory can contact the V.I. Police Department at **340-774-2211**, the Criminal Investigation Bureau at **340-714-9801**, the anonymous tip service Crime Stoppers USVI at **1-800-222-8477**, or **911**.

— Contact Suzanne Carlson at 340-714-9122 or email scarlson@dailynews.vi.

Cruise Ships

Today, Dec. 13

Norwegian Escape (5,400)	8 a.m. to 6 p.m.	Havensight
Carnival Glory (2,974)	11 a.m. to 7 p.m.	Havensight
Carnival Magic (4,675)	Noon to 8 p.m.	Havensight
Harmony of the Seas (6,780)	11 a.m. to 8 p.m.	Crown Bay

Wednesday, Dec. 14

Norwegian Epic (4,100)	7 a.m. to 2 p.m.	Havensight
Norwegian Gem (2,394)	8 a.m. to 5 p.m.	Havensight
Regal Princess (3,560)	10 a.m. to 10 p.m.	Havensight
Grandeur of the Seas (2,446)	9 a.m. to 6 p.m.	Inner harbor
Eclipse (2,582)	8 a.m. to 5 p.m.	Crown Bay
Oasis of the Seas (6,296)	noon to 8 p.m.	Crown Bay

Police blotter

The police blotter is the V.I. Territorial Emergency Management Agency's list of calls to 911 Emergency operators and the time they were reported.

St. Croix

Charged: Assault

George Christopher, 62, of Mon Bijou was arrested at 10:30 a.m. Friday and charged with second-degree assault-domestic violence. Police said he choked a woman. No bail was set per the domestic violence statute.

Charged: Fugitive from justice

Everick Phillip, 31, of Mount Pleasant was arrested at 6:20 p.m. Sunday and charged with being a fugitive from justice. Police said he was wanted on a warrant out of Orange County, Fla. No bail was set.

• • •

Incidents in the police blotter included:

Assault — 10:54 p.m. Sunday, Golden Grove; 3:16 p.m. Monday, Kingshill.

Destruction of property — 12:32 a.m. Monday, Salt River; 11:51 a.m. Monday, Strawberry Hill; 12:09 p.m. Monday, Salt River; 6:30 p.m. Monday, La Reine.

Larceny — 11:17 a.m. Monday, Mutual Homes; 3:15 p.m. Monday, Richmond.

Vehicle tampering — 8:59 a.m. Monday, Hannah's Rest; 12:28 p.m. Monday, La Reine.

St. Thomas

Charged: Assault

Anthony Picot, 31, of Smith Bay was arrested at 2:40 p.m. Saturday and charged with second-degree assault and disturbance of the peace-domestic violence. No bail was set per the domestic violence statute.

Charged: Assault

Kimberley Williams, 27, of Bovoni, was arrested at 5:50 a.m. Monday and charged with third-degree assault-domestic violence. No bail was set per the domestic violence statute.

Charged: Assault

A 17-year-old boy was arrested at 12:10 p.m. Monday in the area of the Lucinda Millin Home and charged with third-degree assault. He was released to the custody of his parents.

• • •

Incidents in the police blotter included:

Assault — 4:32 a.m. Monday, Oswald Harris Court; 4:38 a.m. Monday, Bovoni; 11:50 a.m. Monday, Savan.

Attempted burglary — 6:03 p.m. Monday, Mariendal.

Destruction of property — 3:56 p.m. Monday, Port Authority.

Larceny — 11:42 a.m. Monday, Mahogany Estate.

Unlawful entry — 11:34 p.m. Sunday, Anna's Retreat.

Vehicle tampering — 11:34 a.m. Monday, Port Authority; 7:37 p.m. Monday, Zone C; 7:52 p.m. Monday, Zone C.

St. John

Incidents in the police blotter included:

Larceny — 12:28 p.m. Monday, Zone D.

Outside fire — 11:05 a.m. Monday, Zootenvaal.

Vehicle fire — 2 a.m. Monday, Gerder Marsh Road; 2:43 a.m. Monday, Gerder Marsh Road.

Ivan A. Frazer Muhammed

Ivan A. Frazer Muhammed, also known as BKA Kitchel or Rock City, 80, of St. Thomas, died Tuesday, Dec. 6, 2016, at Schneider Regional Medical Center. He was born Oct. 6, 1936.

Ivan A. Frazer Muhammed

His children and their children; daughter – Denise Frazer; Kneka Dewindt, Rick Lewis and Caprisha Richards; daughter – Cheryl Frazer Jackson; Kevin Jackson Jr. and Chynelle Munnilal; daughter – Elise Frazer; Jaymel Leonard, Jalima Francis, Tiba Francis, Gyasi Francis, Jahmela Maduro, Jamari Maduro and Jarise Maduro; daughter – Rehenia Frazer-Phillip (Akiemba); Rehema (Alika) Jackson, Saitah Aubain, Sencelia Renolds, Quamid (Presidente) Asani and Shaeed Gumbs; daughter – Venise Frazer; daughter – Shenika Muhammed; Jason And Jahni Pemberton; son – Tyrone Frazer; Bajani Frazer, Taj Mahal Frazer, Tamar Frazer, Sohi Frazer, Jahti Frazer, Iibea Frazer; son – Keith Frazer; Jarell Frazer; son – Albert Frazer; son – Ivan Frazer Jr.; his siblings/sister – Rehenia Joshua and Blanche Frazer; and brother – Victor Frazer.

Relatives and friends are respectfully invited to attend the viewing at Christ Church Methodist on Friday, Dec. 16, 2016, at 9 a.m., followed by the service at 10 a.m. Interment is at Western Cemetery No. 3.

Arrangements are under the care of Hurley Funeral Home and Cremation Center of St. Thomas, St. John, St. Croix, and Tortola.

For directions and online condolences, please visit us at www.hurleydavis.com.

Diana S. Richardson

Services will be held Saturday for Diana S. Richardson, 38, of St. Thomas, who died Saturday, Nov. 26, 2016, at Schneider Hospital.

The first viewing will be from 5 to 7 p.m. Friday at the Celestial Chapel of Hurley Funeral Home.

Diana S. Richardson

The second viewing will be from 9 to 10 a.m. Saturday at Church of God of Prophecy in Estate Hoffman. The service will follow at 10 a.m.

Interment will be in Western Cemetery No. 2.

She is survived by her mother, Sonia Richardson; father, Romeo Richardson; siblings, Romeo, Nancy, Sharon, Louise, Karen and Lydia; nephews and nieces, Ly'Dale, Jayziah, Kerrisa, Mokesha, Aaliyah and Kayla; great aunts, Isalene Clomel Shelford, Irene and Frances Hughes, Rita Joseph and Olivia Rievere; aunts, Verna Rollins, Claudette Prince, Janetta Gumbs, Juliette, Era, Christibell and Violet Imogen Richardson; great-uncle, Melvyn Shelford; uncles, Egbert Hood, Aubrey, David and Elroy Prince, David, Wycliffe, McIntosh, Elkin and Sanford Richardson; cousins, Albert, Yves, Egbert Jr. and Tisha Hood, Kim Rollins, Patrick and Patricia Farrel, Toya Rollins, Latrema Simon, Jermaine, Aubrey Jr., David Jr. and Lanna Prince, Diana Williams, Janice, Jewel, and Joslyn Gumbs, Joanna Haley, Nigel, Davida, Daniella, David, Radoykah, Radimiroh, Radiquah, Rohan, Jan, Devaunie, Daeja, Moyagaye, Udlyn, Simone, Leonardo, Ashael, Elson, Elvin, Saniqua and Casey Richardson; the Shelford, Rollins, Nibbs, Maduro and Smith families; and many other extended family and friends too numerous to mention.

Arrangements are by Hurley Funeral Home and Cremation Center of St. Thomas, St. John, St. Croix, and Tortola.

For online condolences visit www.hurleydavisfuneralhome.com.

Germain Petersen

Services will be held Thursday for Germain Petersen, who died on December 6, 2016, at her residence. She was 61.

The viewing will be from 8 to 9 a.m. in the Celestial Chapel at Hurley Funeral Home.

Germain Petersen

The funeral Mass will follow at 10 a.m. at Our Lady of Perpetual Help.

She will be cremated.

She is survived by her husband, Donald Petersen; children, Donald, David and Gina Petersen; daughter-in law, Dawn Petersen; grandchildren, Delano and Destini; brothers, Edward, Edmund and Edville Bryan; sisters, Jeanette Querrard, Joycelyn Harris and June Aubain; sister-in-law, Eleanor Chote; brothers-in-law, Daniel Petersen, Eddie Aubain and Alpha Harris; special family friends, Camille DeCosta and Gilbert Laban Jr.; and many more family and friends

Arrangements are by Hurley Funeral Home and Cremation Center of St. Thomas and St. John. For online condolences visit www.hurleydavisfuneralhome.com.

Catherine Ann Elizabeth Felix

Services will be held Monday for Catherine Ann Elizabeth Felix, 93, who died on Dec. 5, 2016, at her residence.

The first viewing will be from 3 to 5 p.m. Sunday at Hurley Funeral Home.

The second viewing will be from 9 to 10 a.m. Monday at Saint Andrews Episcopal Church followed by the funeral service at 10 a.m.

Catherine Ann Elizabeth Felix

Interment will be in Eastern Cemetery.

She is survived by her brother, William Fergus; sisters, Grace Duberry, Catherine Lizzie White, and Mary Allen; children, Noelise Noel, Glendor Christine Fagan, Catherine Matthew, Emeline Clauretta Felix, Nilda Hector, Elsie Weeks, Joseph Fergus and Winsley Felix Sr.; sons-in-Law, Patrick Hector and Thomas Noel; Grandchildren, Bernard and Robert Attidore; Derrick, Jadine, and Carolyn Allen, Jacqueline and Alicia Fagan; Neuvena Cuffy and Tashina Rogers; Tamika De La Cruz, Kyle and Nathan Felix; Wakima, Yakim, and George Baptiste III, Phillip, Kristal and Keanna Hector; Damali, Shanika, and Kareem Smith, and Geneiva Weeks; Joe-Ann, Joseph Jr., J Daly, Ja'Den Fergus; Carl and Winsley Felix, Jr.; and many more great grandchildren, relatives and friends.

Arrangements are by Hurley Funeral Home and Cremation Center of St. Thomas, St. John, St. Croix and Tortola.

For directions and online condolences visit www.hurleydavisfuneralhome.com.

Prosecutors: white powder letters contained hoodoo curse

By SUZANNE CARLSON
Daily News Staff

A woman facing federal criminal charges for mailing letters containing white powder was attempting to place a hoodoo curse on her enemies, according to court documents filed by prosecutors in the case.

Eugenia Winston, who is facing 32 counts of mailing threatening communications, placed "hotfoot" powder into envelopes containing subpoenas that she mailed to witnesses set to testify against her in a civil lawsuit against her former employer, Scotiabank, according to court documents.

Hoodoo, also known as "rootwork," is a traditional African American folk spirituality that developed from a number of West African spiritual traditions and beliefs.

The detail came in prosecutors' opposition to Winston's motion to suppress all of her statements to authorities, which was filed Monday.

Winston has been free on unsecured bond since Sept. 1, and her civil lawsuit against Scotiabank alleging employment discrimination and harassment has been placed on hold until the criminal case against her is resolved.

At a detention hearing on Sept. 1, Federal prosecutor Chris Fisanick said Winston's actions were a clear threat intended to terrorize the recipients of the letters, and made reference to the 2001 anthrax attacks.

Postal Inspector Eric Oram said at the hearing that the substance was determined to be nontoxic and was likely baby powder, cornstarch, or a similar substance.

Winston's attorney, Assistant Federal Public Defender Gabriel Villegas, argued that Winston is the victim of an unfortunate misunderstanding, and she accidentally spilled body powder over and into the envelopes.

However, Monday's filing by federal prosecutors paints a slightly different picture of Winston's actions.

Hoodoo, also known as "rootwork," is a traditional African American folk spirituality that developed from a number of West African spiritual traditions and beliefs.

"Winston mailed over 30 envelopes that contained 'hotfoot' powder and subpoenas to various individuals in the Virgin Islands. Hotfoot powder is a hoodoo curse designed to prevent witnesses from appearing in court to testify," according to the filing.

"Hotfoot" powder is a hoodoo practice of mixing various ingredients — often some combination of cayenne pepper, Sulphur, copper sulphate, cornstarch and other elements — which is believed to drive away enemies. Commercial versions of the powder also are available for sale online.

Recipients of Winston's letters were mainly witnesses who might testify against Winston in her lawsuit against Scotiabank, and also included U.S. Magistrate Judge Ruth Miller, the legal counsel for Scotiabank and Winston's former counsel in her suit against Scotiabank, according to prosecutors.

Because the envelopes had a return address of the U.S. Courthouse on St. Thomas, "despite the fact that Winston was serving these subpoenas herself," some of the envelopes that could not be delivered were returned to the courthouse and opened by staff there, according to prosecutors.

"Believing the powder to be anthrax or some other deadly biological toxin, the United States Courthouse was evacuated and closed; the employees in the courthouse who were exposed to the powder were quarantined for hours," according to the filing.

The incident caused significant disruption at the courthouse and at the private law office of attorney Bennett Chan near the West Indian Co. cruise ship dock.

"The purpose of lacing these envelopes with hotfoot powder was to instill fear and intimidation in the witnesses to prevent their testifying against Winston," according to prosecutors' filing.

The filing does not indicate how authorities determined the substance in the envelopes was hotfoot powder or what ingredients were in the powder.

Winston admitted to FBI investigators shortly after the envelopes were received that she was the sender. But Villegas has filed a motion to suppress all of her statements to law enforcement, saying she was not properly advised of her right to avoid self-incrimination.

But prosecutors shot back in Monday's filing, saying there is no evidence in a video-recorded interview with Winston that authorities did not properly advise her of her rights or attempt to intimidate her to give a statement in any way.

Villegas wrote in his motion that "the videotaped interview speaks for itself."

However, prosecutors wrote that "the most cursory view of Winston's video recorded interview with law enforcement agents establishes beyond cavil that Winston was never coerced, was properly and repeatedly advised of her rights, and consciously waived those rights," according to Monday's filing. "The first thirty seconds of the interview wholly defeats Winston's meritless motion."

Winston is scheduled to go to trial on Jan. 11 before U.S. District Judge Juan Sanchez.

— Contact Suzanne Carlson at 340-714-9122 or email scarlson@dailynews.vi.

Inter Island Boat Services, Inc.
Ferry Schedule

Tortola

Departs Red Hook / St. John	Day	West End, Tortola
7:15 a.m. / Non-Stop	Mon - Sun	8:00 a.m.
8:00 a.m. / 8:30 a.m.	Mon - Sun	9:15 a.m.
11:00 a.m. / 11:30 a.m.	Mon - Sun	12:15 p.m.
3:00 p.m. / 3:30 p.m.	Mon - Thurs, Sat	4:15 p.m.
4:00 p.m. / 4:30 p.m.	Sun	5:15 p.m.
4:30 p.m. / Non-Stop	Mon - Sun	———
4:30 p.m. / 5:00 p.m.	Fri	5:30 p.m.

Virgin Gorda

Thursdays & Sundays

Departs Red Hook, St. Thomas	Departs St. John	Departs Virgin Gorda
8:00 a.m.	8:30 a.m.	3:00 p.m.

Anegada

1st Sunday of Month (by reservation only)

Departs Red Book, St. Thomas	Departs St. John	Departs Anegada
7:30 a.m.	8:00 a.m.	4:00 p.m.

Jost Van Dyke

Departs Red Hook, St. Thomas	Departs St. John	Departs Jost Van Dyke
8:00 a.m. (Fri & Sun)	8:30 am. (Fri & Sun)	9:15 a.m. (Fri & Sun)
2:00 p.m. (Fri)	2:20 p.m. (Fri)	3:00 p.m. (Fri)
4:00 p.m. (Sun)	4:30 p.m. (Sun)	5:30 p.m. (Sun)

Mon - Wed & Sat

8:00 a.m.	8:30 a.m.	9:15 a.m.
3:00 p.m.	3:30 p.m.	4:00 p.m.

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Email: interisland@islands.vi
Website: www.interislandboatservices.vi

Proof of citizenship required. Acceptable are Passports, Passport Cards or Belonger's Cards. Check-in time is 1/2 hour before departure. Red Hook departs 1/2 hour before St. John. BVI taxes not included. Prices are subject to change.

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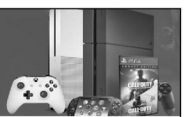

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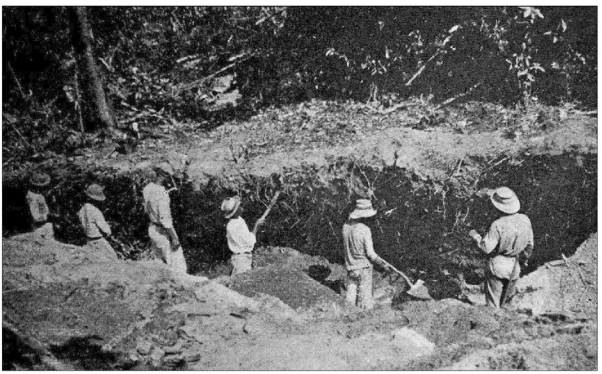
CENTENNIAL SCENE

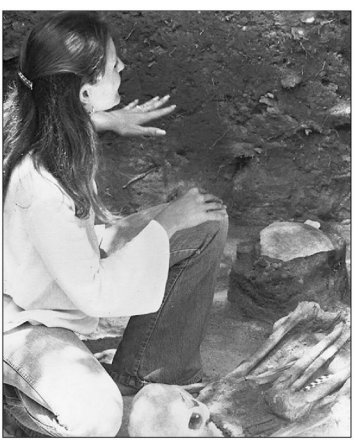
Archaeology in the Virgin Islands

The Cuban Scientific Expedition to the Virgin Islands in 1951 was documented by archaeologists Oswaldo I. Morales Patiño, above, and Fernando Royo Guardia, and subsequently translated and annotated many years later for the Virgin Islands Archaeological Society in its Journal number 5 (1978) by Alfredo E. Figueredo. Morales Patiño was president of the National Board of Archaeology and Ethnology within the Ministry of Culture and Education from 1951-1955. During that same period, Royo Guardia served first as secretary and then treasurer. The visiting Cuban scientists were part of a commission formed, among other objectives, to study and identify possible routes through which prehistoric cultures may have reached Cuba, to seek evidence of the presence of common Cuban influences in Jamaica, Puerto Rico and the Virgin Islands, and to ascertain the spread of Carib influence and identify the culture found by Columbus on St. Croix. Welcomed in the Virgin Islands by Gov. Morris de Castro, they visited and examined four sites. On St. Thomas, they judged the Magens Bay site to be Arawakan culture with a few Igneri specimens. Administrator Harry E. Taylor accompanied the visitors on St. Croix, where they viewed three more sites: Christiansted environs where they examined and collected a number of rimsherds and shell samples; the Salt River midden, with its French fort earthworks foundation, where they were able to excavate pottery, stone, shell and shell bead specimens; and Estate Richmond, where they viewed artifacts, including some Igneri pottery, obtained by the owners from Salt River and from an Indian site on the estate. According to Figueredo, the "importance of this work (by the Cubans) is not due solely to its reports of archaeological remains, however; it is also a historical document, offering us interesting information on the state of affairs, beliefs, and personalities of its time. The Cubans came during one of our minor dark ages — when archaeological work had come to a near standstill, and the history and historiography of the (Virgin Islands) ... were in abject abandon."



Virgin Islands laborers excavate pre-historic deposits at Magens Bay, St. Thomas.

Photo courtesy of THE VIRGIN ISLANDS, OUR NEW POSSESSIONS



Katheryne Brooks Kay-Willock, archaeologist with the Conservation and Cultural Affairs Department, studies the remains of what is believed to be 1,000-year-old skeleton located at Hull Bay beach in 1974 in St. Thomas, at a proposed condominium project.

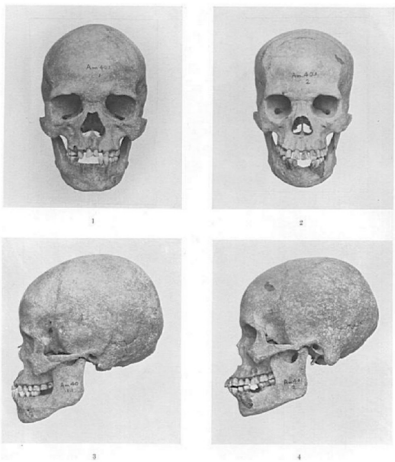
The "ribbon-sealed" bottle, a P.F. Heering Company "Heering's Cherry Cordial" bottle produced in the period 1835-1850, was recovered from the harbor in St. Thomas, where many such items have been discarded over the centuries. The Schenectady (New York) Gazette of Jan. 7, 1981, reported an upcoming lecture presentation to the National Bottle Museum Society in Ballston Spa, N.Y., on the "Buried Treasures of St. Thomas." The newspaper reported that lecturer Gary T. Stephenson "recently returned from the Virgin Islands where he provided consulting services to an individual who has unearthed over 3,000 bottles from an old community dump. The collection dates back to 1700. 'I have never seen so many bottles come out of one dig,' said Stephenson, vice president of the museum society. Bottles in the collection come from Paris, London, Martinique, Canada, Germany and the U.S.A. They graphically illustrate the history of St. Thomas, showing evidence of worldwide trade and commerce. The St. Thomas collection is considered to be the fifth largest collection in the U.S."

Photo courtesy of VAGN PETERSEN'S DANISH BOTTLES

CENTENNIAL SCENE

Fort Salé (formerly Fort Flamand) at the entrance to Salt River in St. Croix is the oldest intact colonial earthwork fort under United States authority. It is also believed to be the only extant earthwork fort in the entire Caribbean. Begun circa 1640 by the English, it was occupied in turn by the Dutch, then the French. The fortifications lie directly adjacent to the Columbus landing site and an ancient Taino ceremonial ball court and plaza. All these features are part of the National Park System's Salt River Bay National Historic Park and Ecological Preserve, co-owned by and managed under an agreement with the government of the Virgin Islands.

The Daily News of May 13, 1938, reported the 1934 discovery by Alvarez Julien of skeletal remains and pottery sherds on Water Island. Based upon the direct association of shells, stone implements and pottery in the area, Julien suspected the remains to be Carib Indian in origin. In 1936 he brought news of his find to the attention of J.C. Trevor, who was conducting field work on the Negroes of the Eastern Caribbean under his fellowship in anthropology at Northwestern University. The skeletal remains had been re-interred and while all could not be relocated, those that could were donated by Julien to Oxford University for further identification and study. Provisionally they were classified as pre-Columbian with further characteristics to be defined and confirmed. The images above and others appeared in the article "Skeletal Remains from the Virgin Islands" in the April 1938 issue of "Man, A Monthly Record of Anthropological Science," published by the Royal Anthropological Institute of Great Britain and Ireland (Vol. XXXVIII, 47-65). According to The Daily News, Virgin Islands "Governor Lawrence Cramer gave permission for the material to be excavated and sent to England."



TWO SKULLS FROM THE VIRGIN ISLANDS.

1–3 male : 2–4 female : about one-third natural size.

An old scale found on St. John and donated to Cruz Bay Museum on July 8, 1974, by Russel Dennem.

Photo courtesy of ARCHAEOLOGICAL RECONNAISSANCE OF THE ISLAND OF ST. JOHN, UNITED STATES VIRGIN ISLANDS, PLATE VII

Petroglyphs at Congo Cay, north of Cruz Bay off St. John.

About the Images: Images provided by the Territorial Archives of the Government of the Virgin Islands, a unit of the Division of Libraries, Archives and Museums of the Department of Planning and Natural Resources. Additional images sourced as otherwise noted. For more information on the holdings of the Territorial Archives, contact Territorial Archivist Susan Lugo at **340-774-0630**, or email susan.lugo@dpnr.vi.gov.

The Virgin Islands
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What's the speed limit on Magens Bay Road? Is it how fast you can run?

Lori Emery

What do the new Magen Bay signs mean?

Public Works installed four of these signs on Magens Bay Road in November in response to the speeding problem.

According to the Merriam-Webster dictionary the abbreviation of miles per hour is "mph" and there should be a number in front of mph designating the speed. On these signs, the number is omitted, so drivers have no idea what the speed limit is.

St. Thomas is an international destination, and we have contemporary street signs that use symbols for walkers, joggers, bicycles etc. I know we can do better in the signage department on Magens Bay Road.

— Lori Emery, St. Thomas

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The Daily News is always interested in publishing local views on topics of general interest, and we especially welcome commentary on issues affecting the Virgin Islands and its people, culture, businesses and government.

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letters@dailynews.vi

The Daily News' opinions are expressed only in its editorials. The opinions expressed in columns, letters, cartoons and guest editorials are those of the particular author or artist.

Where will Trump venture for his first state visit?

Markos Kounalakis

Barbara Streisand and Lena Dunham may be some of the higher profile Trumpfugees leaving the country and heading to Justin Trudeau's Canada. What is less certain is if a President Donald Trump will make Ottawa his first foreign port of call — a long-standing presidential and foreign policy tradition.

Post-election, Trudeau quickly called to congratulate PEOTUS Trump on his victory and the Canadian tweeted, "(W)e agreed to meet soon to keep building the Canada-US relationship."

Trump may want to use the high-visibility first trip to do something other than affirm tradition and reflect the importance and strength of U.S.-Canadian ties. He may want to make a grand strategy statement, letting the world know that he is going to shake-up the global status quo.

Calls to Taiwan, support for the Philippines President Rodrigo Duterte and meeting with Japan's Shinzo Abe have already shaken up the foreign policy establishment's rules for protocol, as well as approaches to human rights and global power relations. All this well-before Trump has even been sworn-in.

Once in office, Ronald Reagan began the tradition of new U.S. presidents making Canada the first foreign presidential visit. George W. Bush notably broke from this tradition, making his first stop Mexico, a country he knew well. He also hoped his trip and Cinco de Mayo parties on the White House lawn would attract Latino voters to the Republican Party.

Trump has already been to Mexico, met with President Pena Nieto, gotten a great presidential photo-op and made his talking points. It is unlikely he will be heading south of the border first.

Making a splash abroad will likely require a large rally — similar or bigger than candidate Barack Obama's visit to Berlin in the summer of 2008 — and may be chosen based on the right mix of pomp, circumstance, strategy and significance.

If two big border nations are knocked out of the running for the primary reception of America's new head of state, where might he go first?

There are any number of early supporters in other countries who could be rewarded and elevated by a presidential visit. The scramble to send invitations to Trump Tower has already begun.

U.K. Prime Minister Theresa May is considering an invitation on behalf of Queen Elizabeth II. Trump's friendship with and preference for Brexit leader Nigel Farage as Britain's next diplomatic envoy will require Trump to balance Buckingham Palace pageantry, the "special relationship," Brexit forces and a potentially restive urban populace before deciding to touch down in London Town.

Numerous foreign leaders supported Trump's candidacy early on, mostly opposition politicians. A few, however, are running countries. They include Hungary's Viktor Orban, North Korea's Kim Jong Un, Zimbabwe's Robert Mugabe and, of course, Russia's Vladimir Putin. Rewarding them with an American inaugural visit would be revolutionary and could set in motion dramatic changes in how America's global relations, alliances and power balancing is perceived and conducted.

Big, bold, groundbreaking unprecedented moves were the hallmark of Trump's campaign: Is there a reason to believe he would take a different approach to governing? Trump's brand of politics is proudly unconventional — from his brand management business to his Fifth Avenue transition tower to his tweet-centric campaign.

Where will he go? Japan, Russia, China, Italy, Germany, France — maybe even India, Australia or Argentina? Tipping favor toward any of the G8 member countries other than Canada for a "first visit" would create both new foreign policy opportunities and challenges.

To avoid granting any nation the favor of a first foray, however, he may decide never to leave the country at all, requiring all foreign leaders visit him at Trump Tower, Mar-a-Lago, the Trump National Golf Club Bedminster … or maybe even the White House.

— Markos Kounalakis is a senior fellow at Central European University and visiting fellow at the Hoover Institution. Contact him at markos@stanford.edu

Employers should not impose religious views on employees

Richard Carroll

In my opinion, Philadelphia Archbishop Charles Chaput is wrong in his view that religious liberty in the United States is under attack (Philadelphia Inquirer and Philly.com, Dec. 8, 2016).

Religious institutions are free to believe and preach whatever they want. I think that what they are not free to do is impose those beliefs on their employees.

For example, a Catholic-affiliated organization may believe that contraception is immoral, but I don't think that organization should be allowed to block its female employees, who may or may not be Catholic, from access to contraception through its medical insurance plans.

I worked for a Catholic organization (the Knights of Columbus) for 30 years. Its 600 employees — most of whom were non-Catholic women — had access to contraceptive coverage through the employer-provided health plan.

Freedom of religion means freedom not to have your employer's religious views imposed on you.

— Richard Carroll, a part-time St. Thomas resident, is the former Associate General Counsel of the Knights of Columbus

Island Life

Lighted Boat Parade

Boats festooned for Christmas wow spectators during the Lighted Boat Parade on Saturday along the Christiansted boardwalk on St. Croix. Above, the crew on Time Out waves to the crowd. Left, Santa makes an appearance. Top left, Live the Dash delivers a message of peace.
Winning entries were: Sail Boats, first place, Time Out; Power Catamarans, first place, Adventure, second place, Gemini/Century; Power Boats Under 25 Feet, first place, Saorise, second, Checkmate; Power Boats 26-32 Feet, first place, Firefly; Power Boats 33-39 Feet, first place, Benita, second place, Golden Eagle; Power Boats 40 Feet, first place, Irie Feelin, second place, Milemark/Rotary; Power Boats 41+ Feet, first place, Reliance (SCUBA), second place, Renewed Interest; Best Lights, a tie between Living the Dream and the U.S. Coast Guard; Best Decorations, La Vie En Rose; Best Animation, Cat Chi; Best Music, Turn & Burn; Best Creativity, Live the Dash; and Best Boat Overall, Heineken Barge.

Daily News photos by ROB JONES

Send us your Island Life news, events and photos

The Daily News is expanding its Island Life section.

Do you have an event, a celebration, or a milestone, including a birth, graduation, wedding, retirement, award, honor or military accomplishment you'd like to share?

Maybe you have a photo from around our islands you think our readers would like to see, whether it's a beautiful sunset, a big catch or people just having fun in the sun.

Help us celebrate our community by sending us your contributions to island-life@dailynews.vi.

The possibilities are endless.

Tribute to a V.I. leader

The community paid tribute to the late Mulo Alwani on Friday with a memorial service gathering at the Mark C. Marin Center at Antilles School on St. Thomas. Alwani, the president of the India Association of the Virgin Islands and a longtime community leader, died on Nov. 19 in Miami after a bout with cancer. He was 79.

Alwani, the former owner of Artistic Jewelers in Charlotte Amalie, had served on the Schneider Medical Center governing board and was a leader in the Rotary and the Masonic Lodge. He was remembered as the "godfather of the Indian community" as well as a friend and a mentor to many.

Ulla F. Muller students attend a pep rally to roll out the school's Positive Behavior Support and Interventions initiative on Nov. 30 on St. Thomas.

Ulla F. Muller students pledge good behavior

Ulla F. Muller Elementary School rolled out its Panther PRIDE Positive Behavior Support and Interventions (PBIS) initiative at a pep rally at the school on Nov. 30. The fun, high-energy event laid the groundwork to teach students the behaviors that make up a positive school environment.

Administrators taught the students the core values of the school through PRIDE: P — positive behaviors, R – respect, I – individual responsibility, D – determination and E – excellence. Students held signs depicting the values while Muller cheerleaders and the Boys & Girls Club performed to rally around the cause.

St. Thomas-St. John PBIS district coach Darian Torrice-Hairston, who is assigned to Ulla F. Muller Elementary, praised the event. "As the PBIS district coach for Ulla F. Muller Elementary School, I have certainly caught the Panther PRIDE! It was evident that the administration, staff and students exhibited their Positive Behavior, Respect, Individual Responsibility, Determination and Excellence. PBIS and its strategies are a priority at Muller and they are working hard to implement the program as it fits their school," she said

Following the rally, teachers will continue to instill the Panther PRIDE principles in students on a daily basis as well as demonstrate what Panther PRIDE looks in each area of the school. School staff will integrate the Panther PRIDE language into daily routines to encourage students to strive for excellence.

The PBIS initiative is rooted in evidence-based practices meant to increase behavioral and academic outcomes by improving school climate, preventing problematic behavior, increasing learning time and promoting positive social skills. Up to five members from each school were selected to attend training facilitated by PBIS coaches from the state and district. School representatives were tasked with producing positive behavior values unique to their institutions and introduce them to teachers and students. The goal of the PBIS initiative is to focus on what the students do right, rather than on what they do wrong to help encourage the repetition of good behavior.

As Muller Elementary continues to support its students through PBIS, additional phases of the initiative will be introduced, such as a positive reward system as well as ceremonies to celebrate student and staff success. With the help of the district coach, Muller's in-house PBIS task force will guide the PBIS initiative to support the school.

Central High School students that participated in this year's "Close Up Washington" trip to Washington, D.C., include Ethaliah Henry, Jenna Malcomb, Nathan McGregor, Destiny Stout, Martisha Charles, Pellis Leonard, Franchel Rodriguez, Jayla Norman, Khaiel James and N'Quelle Golden. History teacher Ericka Hansen is the Close Up adviser.

Students get 'close up' with democracy

Students enrolled in the St. Croix Central High School Close Up organization recently returned from the nation's capital where they attended the Close Up Washington flagship program. The group of 11 traveled Nov. 13-19 and joined with other Close Up high school chapters from across the country to learn about the American democratic process.

Central High School history teacher and Close Up advisor Ericka Hansen took 10 students on the annual trip, which gives high school students and educators an inside look at their democracy in action. Using the nation's capital as their living classroom, program participants get a "close up" view of government processes and places that make the district unique and functional.

Students visited the Washington Monument, Martin Luther King Memorial, the Smithsonian, U.S. Capitol, Arlington National Cemetery, the White House and more. Students also participated in political discussions and met with members of Congress. The program provided social activities for the students in the evening.

Founded in 1971, the Close Up organization has provided more than 825,000 students with educational tours about government and the political processes.

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Club gets facelift

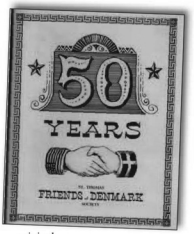
Crowley Caribbean Services went to the Oswald Harris Court neighborhood on St. Thomas recently on behalf of the Crowley Cares Foundation and spent time sprucing up the Boys and Girls Club. Crowley personnel from St. Thomas, St. Croix, and the states helped to clean up and paint the facility and donated furniture for the children to use for their arts and craft programs. The Crowley Cares Foundation allows employees to make monthly contributions, which the company matches, to nonprofit groups in the communities Crowley serves as a cargo carrier. Crowley also delivered a check to help the club purchase a laptop computer. In addition to the contributions, employees donate their time to community groups like the Boys and Girls Club.

Magazine reprint celebrates centennial

To celebrate the centennial of the transfer of government from Denmark to the U.S., the St. Thomas-St. John Friends of Denmark Society announces the facsimile publication of a commemorative magazine printed by the society in 1967. The title is "50 Years: St. Thomas Friends of Denmark Society."

The chairperson of the magazine committee was Eldra L.M. Shulterbrandt. Articles by Omar Brown, Fred Gjessing, Bill LaMotta, Francesca Greve, Gertrude Dudley, Rabbi Sasso and Enid Baa are featured in the magazine. Eldra Schulterbrandt wrote "Quo Vadis" and Gov. Ralph Paiewonsky's stirring "What is Virgin Islander," is printed in full. The editor was Carlos Dowling, with design and layout by Ira Smith. Even the advertisements provide a peek at the islands' past.

The restoration of the initial magazine, including the mixed coloring of the pages, was made possible through digitalization by Bill and Frannie Newbold of Island Business Graphics. It's an accurate reproduction of the original.



The magazines are $25 and are available at the V.I. Children's Museum, Frenchtown Museum and My Brother's Workshop Bakery on Back Street downtown and in Red Hook at Chelsea Drug Store and Sandra's Secretarial Service — Lock and Blade. Additional sites will be announced. Members of the society will also have copies to sell.

Students' cultural calendar also marks V.I. centennial

The students of the St. Croix Educational Complex are working on a collaborative project to celebrate the upcoming centennial anniversary of the U.S. Virgin Islands.

Called the Virgin Islands Cultural Contributors Calendar Creation and Theatrical Performance, the project consists of a 12-month calendar featuring 12 V.I. cultural contributors, accompanied by live interviews.

Visual arts, drama and speech teachers Danica David and Sayeeda Carter are the directors of the project and are using students from their classes and the school's Art Club to bring the vision to life.

Art Club students will use photographs of selected participants to create mixed media portraits for the calendar. Simultaneously, Carter's drama and speech students will conduct interviews with the participants that will be used to create brief write-ups to go along with the graphics.

The cultural contributors were selected based on being natives of the Virgin Islands or residents for at least 15 years and also active contributors to the development of Virgin Islands' culture through fine arts, education, literature, and history.

The students will formally present the finished project at a reception that will feature an art exhibition and theatrical performances embracing V.I. culture and honoring the contributors. The event will take place at St. Croix Educational Complex in January. Calendars are available at the school in December for $12 each.

The Virgin Islands Cultural Contributors 2017 calendar is available at St. Croix Educational Complex for $12.

The educator duo, David and Carter, developed the project so Virgin Islands students could learn about the individuals in their community that aid in the advancement of local culture. The calendar is expected to be produced annually.

The project is sponsored by Rotary Club of St. Croix, Mid Isle and the Community Foundation of the Virgin Islands.

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Holiday Happenings

St. Croix

Arthur A. Richards Jr. High School Music Department presents **Christmas Concert 2016** at 6:30 p.m. Wednesday in the school's auditorium, featuring the Concert Band, Choir, Steel Band and cheerleaders. The Youth Band Dance Ensemble of St. Patrick's School will make a special guest appearance.

•••

John H. Woodson Junior High School invites parents, guardians, and the St. Croix community to its **2016 Christmas Concert**, featuring the Concert Band and the Touch of Love Chorale in the school's auditorium on Thursday at 7 p.m. The December PTA meeting will precede the concert at 5:30 p.m.

•••

The second annual **Holiday Fest** will take place on Friday from 3 p.m. to midnight at Buddhoe Park, bandstand and Strand Street in Frederiksted. Come shop and make it a picture-perfect day with Santa Claus. Vendors are welcome. Contact **340-778-1012**, ext. **6200** or **6206** for more information.

•••

The **Tourism Department,** in collaboration with the **Frederiksted Economic Development Association**, presents a **Community Holiday Giveback with Sunset Jazz** at Buddhoe Park on Friday from 5 to 8 p.m. For more information, go to visitusvi.com.

St. Thomas

Pistarckle Theater presents **"The Nutcracker"** at 7 p.m. Friday and Saturday and at 2 p.m. on Sunday. For tickets visit www.pistarckletheater.com or call **340-775-7877**.

•••

Miracle on Main Street celebrates its 24th year on Friday in downtown Charlotte Amalie, featuring musicians, culinary delights and shopping. For more information, or to become a sponsor, contact the St. Thomas-St. John Chamber of Commerce at **340-776-0100** or email chamber.vi@gmail.com.

•••

Sea View Nursing Home will host its annual **Christmas Gala** on Dec. 22 at the facility on St. Thomas. Cocktails begin at 6 p.m. and presentations will follow at 6:30 p.m. For more information, please contact Simone Edwards at **340-777-3303**.

Briefs

Torah scribe at synagogue

The Hebrew Congregation of St. Thomas welcomes Sofer Rabbi Druin from 5 to 7 p.m. this evening. Druin is in St. Thomas to help the synagogue maintain its historic Torahs and invites you to come learn and ask about the work of the Torah scribe, a 300-year-old craft. For information email info@synagogue.vi or call **340-774-4312.**

AARP meets on Saturday

AARP St. Thomas Chapter 3138 has rescheduled its regular meeting from Dec. 24 to Saturday at 1:30 p.m. in the sun room at Schneider Hospital. The newly elected executive officers and board members will be installed.

Beer & Bacon Bacchanal

Worldwide West and Island Vibes Summer Camp invite you to a Beer & Bacon Bacchanal at The Shops at Yacht Haven Grande pool on Saturday from noon to 6 p.m. For more information on how to participate, volunteer or become a sponsor, call **340-626-3729**, visit www.facebook.com/USVIcamp or email islandvibessummercamp@gmail.com.

The St. John Singers will perform two holiday concerts with guest soprano Laura Strickling on Dec. 21 at Nazareth Lutheran Church in Cruz Bay and on Dec. 23 at Emmaus Moravian Church in Coral Bay.

St. John Singers welcome guest soprano for holiday concerts

The St. John Singers are celebrating their 35th anniversary with a special guest at two holiday concerts during the week preceding Christmas.

Soprano Laura Strickling, who has a home on St. Thomas, will be performing with the choir at their annual concerts in Cruz Bay and Coral Bay on St. John.

Strickling has been described as possessing "a flexible voice, crystalline diction, and warm presence" by a reviewer in the New York Times. She has received numerous awards for her performances of opera, classical and contemporary music.

"We were very lucky to get her," said Janice Ballard, who has directed the St. John Singers for the last five years. "She was on St. Thomas and had only a four-day window between other engagements to sing with us."

The singers' selections will include carols from around the world, and in keeping with the tradition, the audience will be invited to sing along with the choir on a medley of holiday songs.

This year the choir will be accompanied on piano by Arboris de Jesus, a talented young musician who was born in Puerto Rico and raised on St. Thomas. She now studies music at Lawrence University.

The St. John Singers concerts will be held on Dec. 21 at Nazareth Lutheran Church in Cruz Bay, and on Dec. 23 at Emmaus Moravian Church in Coral Bay. Both concerts will begin at 7:30 p.m. Tickets, which are available at the door, are $20. Children are admitted for free.

Ravens-Patriots in AFC showdown Page 34 | Alabama, Ohio State lead All-America team Page 33

The Virgin Islands Daily News
Sports
Tuesday, December 13, 2016

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STX Educational Complex takes win over P.R.'s Juncos Broncos

By DAVID EDOLE
Special to the Daily News

ST. CROIX — The St. Croix Educational Complex High School's tackle football exacted some revenge for the Virgin Islands, roughing up Puerto Rico's Juncos Broncos, 20-8, on Saturday night.

Scott Cofiell

The Barracudas, behind the duo of Vernon Clarke and Cristian Perez, ran out to a 14-0 halftime lead.

Clarke, Complex's quarterback, called his own number in scoring on an 18-yard run. He then handed off to Perez, the Barricudas' tailback, who scampered for a 12-yard score.

The extra points were good by Roland Richards both rushing, but were awarded one point each.

"We didn't know that the National Federation of High Schools changed the rules on extra points," said Educational Complex head coach Scott Cofiell. "The new rule is one point for a rushing and two for passing."

Complex poured it on in the second half when defensive end Antonio

See **BARRICUDAS,** page 35

Photo courtesy SCOTT COFIELL

St. Croix Educational Complex High School quarterback Vernon Clarke, center, hands off to tailback Cristian Perez during Saturday's game against the Juncos Broncos at Pista Atletica Municipal de Juncos in Puerto Rico. The Barricudas went on to take a 20-8 victory over the Broncos.

V.I. swimmers take gold at P.R. Nationals

By BILL KISER
Daily News Sports Editor

Swimmers from two Virgin Islands swim teams brought home a combined 49 medals from the Puerto Rico Short Course National Championships, held Dec. 2-4 at the San Juan Natatorium.

Webster Bozzo

The St. Thomas Swim Association (STSA) team finished eighth overall in the combined team scoring, while the St. Croix Dolphins (SCD) came in 12th. Puerto Rico's Bayamon Swimming Team won the overall team title.

St. Thomas swimmers won 13 events, finished second in seven events and third in five others. St. Croix swimmers won in eight events, and finished second in eight others and third in eight events.

St. Croix's Webster Bozzo led all the Virgin Islands swimmers with five gold medals, posting the top times in the boys 15-16 division in the 100- and 200-meter backstroke, 100- and 200-meter freestyle, and the 200-meter individual medley. He also finished second in the 100-meter

See **SWIM,** page 35

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BARRICUDAS

CONTINUED FROM PAGE 36

Polanco picked up a fumble and returned it for score to push the Barricudas' lead to 20-0.

"Our defense played very well," Cofiell said. "Aderemi Flores had an interception and had a couple of returns of 40 yards. Lejoni Williams was all over the field and led us in tackles."

The Broncos added a late touchdown from Diego Luna and two-point conversion from Hernan Velez for the final score.

"I was playing all my guys at that point," Cofiell said. "I wanted to give everyone the experience of playing in Puerto Rico."

After the game, the Broncos set up a meet-and-greet between both team and an innovative idea came out of it.

"They took care of us all weekend," Cofiell said. "They gave us a place to stay and ground transportation. They even took us sightseeing of old San Juan before being dropped at the airport.

"We invited them to come to St. Croix and play us during the Virgin Islands-Puerto Rico Friendship weekend; hopefully it could be a yearly thing. Either they come one year or we go, this was a positive experience for us."

"This was an amazing event," Juncos head coach Manuel Santiago said. "We were very happy to host them and we enjoyed them, too. This was an excellent opportunity to open our relationship and we are working on coming to St. Croix in October."

St. Thomas schools Charlotte Amalie and Eudora Kean, the 2016 St. Thomas-St. John IAA champs, played teams from Puerto Rico last month, losing to the Dorado Spartans and University Garden Dolphins, respectively, in games played at Lionel Roberts Stadium.

"I think we should have a combined league with Puerto Rico," Cofiell said. "We play one home and one away every year. Look, our ticket cost $150, that's not much more than flying to St. Thomas. It could be done. But before we approach Puerto Rico, we would need a unified league between St. Thomas and St. Croix agreeing on stuff to make it happen. Then we could move on to Puerto Rico, They are not that far away.

"They are more Puerto Rican teams than Virgin Islands teams. A mixed schedule will have to be created with a Caribbean champion between the winners of each league. People are really interested in playing in football. If we're going to grow, we need to play good teams to get better and Puerto Rico has been playing a while."

The Puerto Rico High School Football League is presently comprised of seven teams — Antilles High School, Baldrich Comets, Parque Central Bluewaves, Parkville Steelers, Juncos Broncos, Dorado Spartans and the University Gardens Dolphins.

Photo courtesy SCOTT COFIELL

The players and coaches from the St. Croix Educational Complex and Juncos Broncos football teams gather at midfield for a postgame photo after the Barricudas' 20-8 win over the Broncos on Saturday at Pista Atletica Municipal de Juncos in Puerto Rico.

SWIM

CONTINUED FROM PAGE 36

individual medley and 50-meter backstroke.

Mary Killman led St. Thomas with four gold medals, winning in the girls 19-under division in the 50-, 100- and 200-meter backstroke, and the 200-meter individual medley. She also finished third in the 50-meter freestyle.

Killman also set meet records in two events, with her time of 30.09 seconds in the 50 backstroke shattering the old record by 1.24 seconds, and her time of 1 minute, 5.08 seconds in the 100 backstroke breaking a 14-year-old record by 1.14 seconds.

St. Thomas' Audrey Moore and Ky Odlum, and St. Croix's Matthew Mays won three events each.

Moore took gold in the girls 11-12 division's 50- and 100-meter freestyle events, and teamed with Carter Maltby, Casey Vanderwall and Ana Pia Brunt to take the 200-meter freestyle relay. She also took seconds in the 200-meter freestyle and 200-meter individual medley, and teamed with Vanderwall, Maltby and Brunt to take second in the 200-meter medley relay. Moore also finished third in both the 400-meter freestyle and 100-meter individual medley.

Odlum won in the boys 13-14 division in the 50-meter freestyle, 50-meter backstroke and 100-meter butterfly. He also finished second in the 50-meter butterfly, and third in the 100-meter individual medley.

Mays won in the boys 17-18 division in the 100-meter individual medley, 200-meter backstroke and 200-meter individual medley. He also finished second in the 200-meter freestyle and 200-meter butterfly, and third in the 100-meter freestyle.

Other gold medalists were St. Thomas' Max Wilson (boys 11-12 200-meter backstroke), and STSA's girls 9-10 200-meter freestyle and 200-meter medley relay teams, both composed of Gabriela Brunt, Fairley Maltby, Alex Otwell and Lindsay Barr.

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From: Richard Kahn [redacted]
Sent: 12/15/2016 5:40:04 PM
To: jeffrey E. [jeevacation@gmail.com]
Subject: Fwd: 2016 Election: Tax Changes Expected
Attachments: image001.png; Untitled attachment 417590.htm; Tax Alert 2016-5.pdf; Untitled attachment 417593.htm

Importance: High

Richard Kahn
HBRK Associates Inc.
575 Lexington Avenue 4th Floor
New York, NY 10022
tel 212-971-1306
fax 646-350-0954
cell 917-414-7584

Begin forwarded message:

From: "Ens, Amanda" <[redacted]>
Subject: 2016 Election: Tax Changes Expected
Date: December 15, 2016 at 9:51:37 AM EST
To: Richard Kahn <[redacted]>

Rich, following up on your question from a while back about this topic. Please find a white paper attached.

Regards,
Amanda

The election of Donald Trump as President is expected to lead to significant tax law changes. The tax changes may come in two parts: from the repeal of the Affordable Care Act (ObamaCare) and its related taxes and from comprehensive tax reform. Since Republicans will also have majorities in both the House and Senate, such changes could be undertaken without bipartisan support. Although it is not yet known exactly what the changes will be or when they would be effective, we are issuing this Tax Alert to inform you of changes that are anticipated, based on proposals made during the campaign by both President-elect Trump and the House Republicans. We also discuss how these changes may impact your planning, both currently and in the future.

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The 2016 Election: Tax Changes Expected

INTRODUCTION

The election of Donald Trump as President is expected to lead to significant tax law changes. The tax changes may come in two parts: (1) from the repeal of the Affordable Care Act (ObamaCare) and its related taxes and (2) from comprehensive tax reform. Since Republicans will also have majorities[1] in both the House and Senate, it is anticipated that such changes could be undertaken without the need for bipartisan support. It is likely that the Affordable Care Act, and its taxes, could be repealed in early 2017 and result in an immediate tax cut for dividends, capital gains and high-income earners. It is more time consuming to enact comprehensive tax reform and such efforts may not result in a tax bill until mid-summer or the fall, which could push the effective date of broad-based tax changes into 2018. Although it is not yet known exactly what the changes will be or when they would be effective, we are issuing this Tax Alert to inform you of changes that are anticipated, based on proposals made during the campaign by both President-elect Trump and the House Republicans. We also discuss how these changes may impact your planning, both currently and in the future. When we have more specifics, we expect to issue another Tax Alert.

	Current Law*	Trump Plan	House GOP Plan
Individual Tax Rates	10, 15, 25, 28, 33, 35, 39.6%	12, 25, 33%	12, 25, 33%
Top Capital Gains/Dividend Tax Rate	20% (plus 3.8% surtax)	20%	16.5%
Itemized Deductions	3% of itemized deductions are lost when adj. gross income exceeds $313,800 ($261,500 if single)	Limited to $200,000 (couples); $100,000 (singles)	Eliminates except for charitable and (likely capped and modified) mortgage interest
AMT	Parallel tax calculation	Eliminates	Eliminates
Investment Surtax	3.8%	Eliminates	Eliminates
Estate Tax	40% rate, $5,490,000 exemption	Eliminates (capital gain at death subject to $10 million exemption)	Eliminates

*Inflation adjusted amounts for 2017

INCOME TAX

Current law. Ordinary income can be subject to rates as high as 39.6%, and capital gain can be subject to rates as high as 20%. In both cases, an additional 3.8% surtax might apply. Certain itemized deductions are "phased out" under the so-called "Pease limitation" when adjusted gross income reaches certain thresholds. The Alternative Minimum Tax can result in additional tax liability. The income from so-called "carried interests" is taxed as capital gain.

[1] In the House of Representatives, a simple majority is sufficient to pass legislation. It is more complicated in the Senate, where 60 votes (a super majority) are required to avoid a filibuster. Republicans have a simple majority, but not a super majority, in the Senate. However, there is a budget procedure known as Reconciliation, which allows certain legislation to be passed without filibuster. Accordingly, it would appear that Republicans could pass tax legislation in the Senate with just a simple majority.

Proposals. Both President-elect Trump and the House Republicans would lower the top tax rate for ordinary income to 33%. President-elect Trump would maintain the top rate on capital gains at 20%, though it might be applicable at a lower threshold than current law. House Republicans would lower the top rate on capital gains to one-half of the highest rate imposed on ordinary income, or 16.5%. Both President-elect Trump and the House Republicans have proposed repealing (and replacing) the Affordable Care Act, which is the source of the current 3.8% surtax. The Affordable Care Act is also the source of the extra 0.9% surtax on high-income earners (wages exceeding $250,000 for couples; $200,000 for singles) and other indirect tax increases such as the reduced cap on flexible spending accounts and tighter rules for deducting medical expenses. A repeal of the Affordable Care Act could lead to an immediate tax cut. President-elect Trump would impose a $100,000 cap on itemized deductions ($200,000 for joint filers); the House Republicans would eliminate itemized deductions other than charitable gifts and mortgage interest. Both President-elect Trump and the House Republicans would eliminate the Alternative Minimum Tax. President-elect Trump's proposal would tax the income from "carried interests" as ordinary income.

Planning. At its most basic, income tax planning is (i) timing income so it is recognized in a lower-tax year, and (ii) timing deductions so they are deducted in a higher-tax year. However, the proposals listed above contain both "good news" and "bad news" for 2017, so we cannot offer a universal rule as to whether income or deductions are better recognized in 2016, 2017 or even 2018. Each taxpayer needs to make an educated prediction. If there is not a clear answer, sometimes it can make sense to recognize some income (or deductions) in one year and some the next. That approach has the benefit of making sure you don't completely pick the worse year.

The following are some general planning considerations.

- **Installment sale.** If a sale is made in return for an installment note, the resulting gain can be reported on the installment method, meaning gain can be deferred into the year in which payment is received. Not all assets can be sold via the installment method, and there are several special rules. For example, marketable securities cannot be sold and reported using the installment method. We have a separate Wealth Strategy Report: *Installment Sales.*

  If a sale is made for an installment note, you can also elect to be taxed in the year of sale rather than deferring the gain. This election must be made by the due date (including extensions) of the return for the year in which the sale occurred. Thus, an installment sale in 2016 could allow you to wait until as late as October 2017 to decide whether to use the installment method or report all the gain in 2016. This could allow a decision to be made with 20/20 hindsight, at least as of October.

- **Equity-based income**. Certain types of compensation are tied to the value of an underlying stock. As one example, a nonqualified compensatory stock option's value will vary with the changing value of the underlying stock. As another example, a grant of restricted stock will be taxed when it vests, unless a so-called "83(b) election" is made to be taxed at the time of grant. In either case, the amount of compensation that is taxable will depend on the value of the stock at the appropriate time. When deciding the most favorable tax year to recognize these types of equity-based compensation, in addition to the usual considerations of the applicable tax rate, it is important to account for the expected investment performance of the underlying stock. As a simple example, deferring a stock option exercise to the next year might produce a better result not because of a better tax rate but because of the expected growth in the stock's value.

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- **Roth conversions**. It is generally better to convert traditional retirement funds to a Roth IRA in a lower tax rate environment rather than a higher rate environment. For taxpayers who converted a traditional IRA to a Roth IRA in 2016, the normal rules will provide a chance to review whether 2016 or 2017 would be the better year for a conversion. Generally, a 2016 conversion can be unwound ("recharacterized") as late as October 16, 2017. Following a recharacterization, the IRA could again be converted to a Roth IRA 30 days later (assuming the original conversion occurred in 2016). Thus, you could wait until October 2017 to determine whether 2016 or 2017 would be the better year for conversion based on the relative tax rates, changes in the market value of the retirement funds and other relevant considerations. If 2016, then you could let the 2016 conversion remain. If 2017, you could "recharacterize" in October of 2017 and re-convert 30 days later.

ESTATE AND GIFT TAX

Current law. Under current law, the federal exemption for estate and gift tax is $5 million, subject to an inflation adjustment each year. For 2016, the exemption is $5,450,000, and for 2017, it is $5,490,000. For gifts or estates above the exemption, the federal tax rate is 40%. If an appreciated asset is includible in the estate, it generally receives a step-up in basis for income tax purposes equal to the fair market value at death. Accordingly, there would be little or no capital gains tax for appreciated assets sold soon after death.

Proposals. President-elect Trump has proposed to repeal the estate tax. The House Republicans' Tax Proposal also proposes federal estate tax repeal. It would appear that such repeal would be temporary, unless the tax changes proposed can be enacted on a revenue neutral basis.[2] It is not clear whether the federal gift tax would also be repealed. The federal gift tax may be viewed as serving two purposes. First, it serves to support the estate tax, because without it you could make unlimited gifts during your life and thereby avoid federal estate tax at death. From that perspective, repealing the estate tax would suggest that the gift tax would also be repealed. However, the gift tax also serves to support the federal income tax. Without a gift tax, income-producing property could be given to family members or others in a lower tax bracket (or residing in a state without an income tax), and subsequently given back. From that perspective, repealing the estate tax would not suggest that the gift tax also be repealed. Neither President-elect Trump's proposal nor the House Republicans' Tax Proposal includes a repeal of the gift tax.

As noted, appreciated assets includible in the estate generally receive a step-up in basis. President-elect Trump has proposed to change this, however specific details have not been offered. The proposal sets forth a $10 million exemption for gains at death. It is not clear whether this exemption is for each decedent, or if that is the combined exemption for a married couple. It is also not clear whether any gains above the exemption would be subject to capital gains tax at death (in effect a deemed sale at fair market value), or only subsequently when the asset is actually sold. It is also uncertain whether any unused exemption could be transferred to a surviving spouse.

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[2] In order to comply with the Reconciliation procedure, the repeal needs to "sunset," resulting in reinstatement of the estate tax after approximately 10 years. Under the 2001 Tax Act, there was a temporary repeal of the estate tax (and other taxes) for this reason. Reconciliation rules will likely also add pressure to produce a revenue-neutral tax bill in order to avoid such a "sunset." That could cause Congress to abandon repealing the estate tax.

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Valuation discounts. On August 2, 2016, the IRS released proposed regulations, which may limit valuation discounts for transfers of interests in family-controlled entities.[3] These regulations contain many ambiguities, and the IRS requested comments and held a public hearing on December 1, 2016. The regulations are controversial, many comments were sent and only a few clarifying changes were provided at the hearing. As a result of the election, we believe it is likely the IRS will not proceed with these regulations. For now, there has been no official word from the IRS.

Planning. The proposal to repeal the federal estate tax appears straightforward, but will be complicated if it is temporary. The possibility of reinstatement of the estate tax may be a reason for traditional estate planning techniques, such as gifts and sales, to continue to be utilized. There is also significant uncertainty as to the related federal gift tax and basis step-up proposals. This makes current planning difficult because you may be comparing the consequences of taking action currently (such as making a gift), with the uncertain future consequences of not taking such action. Nevertheless, there are some general guidelines to consider.

- It does not appear advisable to make a current gift that requires the payment of gift tax. Although the gift tax may be less costly than the estate tax, that would not be true if the estate tax is repealed.
- There are many types of "free" gifts that do not require the payment of gift tax, such as annual exclusion gifts, tuition and medical gifts, gifts utilizing the lifetime gift exemption, and zeroed-out GRATs.
    - If such gifts are being considered only to save estate tax, it does not appear necessary to make these gifts, unless there is an applicable state estate tax[4]. However, if repeal is temporary and the estate tax will be reinstated, then such gifts may continue to be advisable.
    - If such gifts are being considered for other non-tax reasons (such as benefitting the recipient or asset protection), such gifts may still be beneficial. Even if the gift tax were repealed, you would still have made the gift for free.
    - If a gift will be made currently, it may be advisable to include flexible provisions, such as a trust which allows for discretionary distributions to the donor's spouse. This could allow the gift to be "undone" in the future by distributions to such spouse, if that becomes desirable.

As to future planning, it will obviously depend on what changes are enacted. If the estate tax is repealed, or if other significant changes are made, all wills, trusts and estate planning documents should be reviewed to determine if any revisions are desirable. Since most wills have dispositive provisions, such as credit shelter trusts and QTIP trusts, based on the estate tax, it will require a re-thinking of estate planning and what dispositions and trusts would be appropriate. Non-tax considerations, such as trust provisions, asset protection and fiduciary selection, will play an enhanced role. If federal estate tax repeal is only temporary, it will presumably be necessary to include alternate dispositive provisions, in case the tax is reinstated.

CONCLUSION

The results of the 2016 election are expected to lead to significant income and transfer tax changes, some through the potential repeal of the Affordable Care Act and others through a push for comprehensive tax reform. In this Tax Alert, we have highlighted some of the tax proposals, and the possible impact these changes may have on

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[3] We have a separate *Tax Alert 2016-3, Proposed Regulations May Limit/Eliminate Valuation Discounts for Family Controlled Entities*.

[4] Certain states impose their own estate tax, independent of whether the federal estate tax is repealed.

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planning. It is our view that due to fiscal and political pressure to keep future budget deficits in check and the narrow corridor which could result in the passage of a major tax bill (Reconciliation), we expect the tax bill to be closer to the House Republicans' Plan than the Trump Plan and perhaps narrower in scope. When more information is available, we expect to issue a more detailed Tax Alert.

— **National Wealth Planning Strategies**

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From: Richard Kahn [redacted]
Sent: 12/15/2016 5:46:20 PM
To: jeffrey E. [jeevacation@gmail.com]
Subject: Fwd: US Healthcare Year Ahead...Buy ACAD, AGN, ANTM, CELG, CVS, DHR, EW, EVHC, RARE, REGN, WBA
Attachments: image001jpg01D256A2F263C080.jpg; image001gif01D256C23AC52B10.gif

Importance: High

attached are equity healthcare ideas

Richard Kahn
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Begin forwarded message:

From: "Ens, Amanda" [redacted]
Subject: US Healthcare Year Ahead...Buy ACAD, AGN, ANTM, CELG, CVS, DHR, EW, EVHC, RARE, REGN, WBA
Date: December 15, 2016 at 10:59:39 AM EST
To: "Rich Kahn" [redacted]
Reply-To: "Ens, Amanda" [redacted]

The US team is out with their 2017 Year Ahead this morning (link) running through ALL sub-sectors with each analysts top pick into the new year.

Top Picks – ACAD, AGN, ANTM, CELG, CVS, DHR, EW, EVHC, RARE, REGN, WBA

Washington DC Backdrop
Given the clean sweep by the GOP & uncertainty around the ACA, key attention is paid by Andy Bressler to a review of the various scenarios that could play out early next year. With a repeal likely to happen well before a replace (essentially via the Budget Reconciliation process in Jan/Feb), Andy notes this is likely to include a repeal of both health insurance exchange subsidies & a phase-down of Medicaid expansion funding (albeit with a two or three year transition period).

He also expects a repeal of many of the larger HC related taxes in the ACA, including the HIX ($14.3bn in 2018), Medtech Tax (2.3%), pharma industry tax ($4.1bn in 2018) & Cadillac tax (effective 2020).

As for the views by analysts…
Biotech (+) – believe sector will outperform largely as pricing risk has diminished (although will remain in pockets) but pipelines/growth remains. Ying's top picks are **CELG** & **REGN**; Tazeen's top picks are **ACAD** & **RARE**.

Spec Pharma (-) – headwinds remain w/ Sumant's top pick **AGN** given lower risk to reimbursement pressures & an underappreciated pipeline. Leverage & CF remain the key focus for investors.

Tools/Animal Health (=) – Derik notes more "headline" than "real" risks from policy which will create opportunities for a group growing MSD, although valuations remain above peers. **DHR** (US 1 name) top pick, also **A**, **ZTS** in Animal Health, **BDX** in Diagnostics & **CTLT** in Services.

Medtech (=) – Hopkins' expects a mixed bag in 2017 w/ stocks trading close to 5yr valuation lows; **EW** top pick given best growth / purest innovation story.

Facilities (-) – Fischbeck notes that uncertainty will remain an overhang for hospitals as repeal/replace a negative for the group (est losing 2-3mm Medicaid lives & 2-3mm exchange lives would be a 1-2% EBITDA hit on avg). Focus on company-specific stories like **EVHC**.

MCOs (+) – Fischbeck generally +ve under Trump (especially around MA given historical support from GOP) w/ tailwinds from corporate tax & rising rates. **ANTM** top pick in given valuation & tailwinds.

Distribution/Tech (=) – Valiquette prefers pharmacies **CVS/WBA** given benefits from decelerating generic prices (which will remain an overhang for Distributors). HHS appointment a –ve for HCIT.

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From: Morris, Paul V [redacted]
Sent: 1/5/2017 3:31:54 PM
To: Morris, Paul V [redacted]
CC: Lehane, Sean T [redacted]
Subject: The Year Ahead: A World of Change (Short Version Below For Convenience)
Attachments: image001.jpg; image003.jpg; image004.jpg; image005.png; image006.jpg

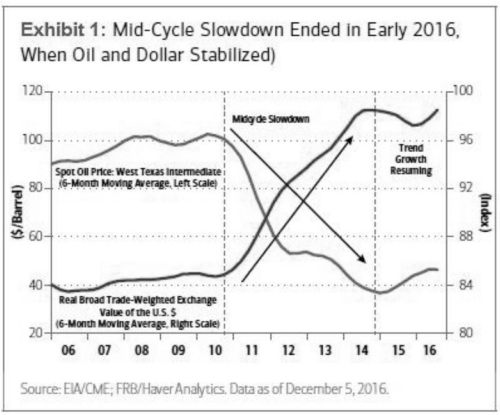
The Year Ahead: A World of Change

A continued rise in equities. Renewed investor confidence. Bond markets under pressure. Our Chief Investment Office explores the risks and opportunities of these and other trends shaping the year ahead.

AS WE LOOK BACK ON 2016, one could characterize it as The Year of The Unlikely. It began with deep worries regarding China's growth path, a second wave of collapsing oil prices, a Federal Reserve (Fed) hiking into deflationary headwinds, the impact of negative interest rates in Europe and Japan, concerns over a potential U.S. recession, lower-quality corporate

high yield problems, and U.S. consumers who might never spend their savings at the pump. All these worries hit at once in January and February, prompting the S&P 500 to fall over 10% from its 2015 closing level of 2043. The year, at that point, appeared bleak.

Our view was to maintain a balanced and diversified position throughout the downturn, particularly for the long haul, due to our belief that the major concerns, although understandable, were simply not going to fully develop and asset prices would begin to track fundamentals more effectively through the remainder of the year. The potential for risk assets to climb higher was there but a catalyst was needed. For our full view on the year ahead, please read our December 2016 Monthly Letter.



Past performance is no guarantee of future results.

Our core belief was centered on healthy consumers who would indeed pick up their spending from savings at the pump and become more confident as job growth continued and real incomes increased. We also believed U.S. financial conditions and the economic backdrop would improve in the second half of the year as the pressure from the strong dollar subsided and the deflationary effects of the collapse in oil prices began to fade. In other words, we were witnessing evidence that the mid-cycle slowdown that had hurt economic growth and corporate earnings was ending. [See Exhibit 1] Based on this core belief, the "grind it out" year for risk assets would be back on track, the business cycle would extend into 2017, bond yields would slowly shift higher, and equity markets had the potential to head toward previous highs.

A series of unexpected outcomes

At this point, we did not characterize 2016 as The Year of the Unlikely. However, if you consider specific events throughout the year in finance and sports, it is easy to see that now. We already mentioned the second plunge in oil prices to the mid-$20s per barrel to start the year, and bond markets in some areas of the world actually had negative yields—meaning the lender paid the entity issuing the bonds to take their money! This was unlikely. How about Brexit vote in Great Britain? Unlikely. In sports, Villanova University winning the national championship in men's college basketball (Nova's first championship since 1985), Leicester—the English football club—

winning the Premier League (before this season began, British bookmakers listed them as a 5,000-to-1 shot to emerge as the champion), the Cleveland Cavaliers' first ever National Basketball Association championship and, of course, the Chicago Cubs winning the World Series for the first time since 1908! All unlikely. But they happened.

Last but not least, in our own political backyard, we witnessed Donald Trump's victory in the U.S. presidential election last month. Also unlikely. We all know markets do not like uncertainty. However, sentiment can shift quickly if fundamentals are not negatively affected, and what was previously determined to be "unlikely" turns to enthusiasm as to what could be.

"We expect business, consumer and investor confidence to continue to head higher well into 2017, with most of the newly expected growth to come in 2018, which should underpin equities for most of the year."

CHRISTOPHER HYZY
CHIEF INVESTMENT OFFICER, BANK OF AMERICA GLOBAL WEALTH AND INVESTMENT MANAGEMENT

Why this expansion can continue

Business cycles typically last between five and seven years before fundamentals deteriorate, usually due to a policy error of some sort. This can produce a recession and/or a bear market, which tend to correct the excesses that have been built up and kick-start a new cycle. Bull markets and cycles do not die of old age—there needs to be a fundamental catalyst that emerges and pushes the trends back the other way.

We are entering our ninth year in the current business cycle, despite all of the complexities and concerns that have come and gone since the financial crisis.. In fact, this cycle could have extended another few years along the same path, given the secular stagnation that prevailed. This era needed ultra-accommodative central bank monetary policy just to keep things stable and plodding along this far into the cycle. It also needed corporations willing to manage their earnings to the penny in a below trend growth world that offered little pricing power. And finally, this cycle needed U.S. and emerging market consumers to continue to switch from deleveraging to spending as their balance sheets and incomes improved.

A return of "animal spirits"

This dynamic could have continued for a bit, but monetary policy has become tired. Negative interest rates have become a headwind, not a tailwind, in our view. And, just like sports fans, investors need a catalyst to break from the past. Visible positive catalysts tend to turn into improved sentiment and confidence. Through the years, economists have called this "animal spirits."

Animal spirits begin as hope, turn into enthusiasm, and ultimately need visible action to keep the spirited momentum going. After all, economics is a behavioral science. It is our view that we are breaking from the era of secular stagnation and heading into fiscal reflation. This new era is likely to have its fits and starts and will not be in a straight line. It should also include different stages and speeds from various economic regions globally. Furthermore, it should contain some "unlikely" outcomes. With any cycle, we will have to take the good (higher nominal growth) with the potential

bad (higher volatility) and investors will have to reposition portfolios, rebalancing when necessary, in order to take advantage of the new era.

Prior to the U.S. presidential election, and even dating back to the summer months when bond yields bottomed, the economy was already beginning to improve. Corporate earnings were picking up, the consumer was spending at a healthy clip, there were some subtle signs of positive surprises in European economic activity, and the downturn in emerging markets (and negative earnings revisions) ceased. We were certainly not waving the celebratory flag on growth, but the economy was getting up off the ground, which is what risk assets, including equities, need sometimes. However, the S&P 500—a major benchmark for U.S. stocks--had lost momentum heading into the election, as investors worried that the secular stagnation era would continue and that monetary policy had lost its effectiveness.

Market sentiment changed dramatically during the early morning hours on November 9. The surprise victory by Donald Trump caught many investors off-guard. The potential for fiscal stimulus measures, reduced regulation, corporate tax reform and other potential pro-growth initiatives increased. Animal spirits perked up. Investor positioning was heavily skewed toward long-duration fixed income, low-volatility equities and high-dividend-paying companies. These areas significantly outperformed in the first half of the year but started to lose momentum once rates bottomed mid-year. However, investor positioning did not change materially at first. Portfolios were still generally overexposed to higher- quality, rate-sensitive investments—otherwise known as "bond proxies."

In our Hills Have Eyes strategy report, published on November 16, we outlined the need to rebalance portfolios given our belief that we were already transitioning toward the late-cycle expansion phase and that the new enthusiasm for pro-growth policies would begin to accelerate investor flows toward more cyclical investments. Given the high degree of underexposure to late-cycle investments by investors, we believed such a rotation would cause a "melt-up" in equities toward new highs over time.

Diversification and rebalancing will be key

So, how are we going to manage portfolios in a world undergoing a major market regime shift, one that is transitioning from the era of secular stagnation to fiscal reflation, and one that still has a considerable amount of uncertainty? We are going to become more prescriptive, remain diversified and balanced, but with more exposure to pro-growth, pro-cyclical areas. We will also likely rebalance more often throughout the year as investor rotation gathers momentum during 2017 and into 2018; and we look to periods of volatility as opportunities to add to areas we favor.

"Fixed income still represents an important portfolio diversifier—and a volatility dampener in unforeseen worst-case scenarios."

CHRISTOPHER HYZY
CHIEF INVESTMENT OFFICER, BANK OF AMERICA GLOBAL WEALTH AND INVESTMENT MANAGEMENT

We expect business, consumer and investor confidence to continue to head higher well into 2017, with most of the newly expected growth to come in 2018, which should underpin equities for most of the year. Higher nominal growth, an improved picture for corporate profits and continued

positive sentiment are the foundation for continued gains in the equity markets and an investor rotation from overexposure to long-dated fixed income into under owned equities.

This rotation will need a few periods of confirmation, given the still uncertain broader global macro outlook, but we expect price-to-earnings multiples to remain elevated, despite higher rates, throughout the year. S&P 500 earnings have a wide range of forecasts due to the potential for sizable tax cuts in 2017. Based on this, the S&P 500 could add extra earnings on top of normalized growth, which is expected to be around 9%. At present, a reasonable range, albeit a wide one, is considered to be between $129 and $138 with the potential for further upside. In this scenario, where we get pro-growth policies filtering into a higher earnings number, an S&P 500 bull case level of 2700 at the high end is possible.

Improving profits and growth should take equities higher

For now, a base case utilizing the five factor framework from BofA Merrill Lynch Global Research, which combines sentiment, valuation and technical, equates to 2300 for the S&P 500 at year end. The two components that include long-term valuation and 12-month price momentum are indicating that S&P 500 levels between the base and bull case are increasing in probability. Of course, there are a number of scenarios that could unfold that would indicate a wide range of outcomes depending on the multiple or earnings number that ultimately develops. In the end, it all comes down to the path of corporate profits and the visibility on growth, both of which are improving.

Highlights

We have moved from a "get paid to wait" core portfolio theme to a more cyclical- and value-oriented theme in multi-asset portfolios

- Equities remain attractive versus fixed income on a relative basis.
- Within equities, we favor U.S. large caps, U.S. small caps and emerging markets.
- Within equities, we favor value over growth and more cyclical assets versus defensives.
- Within fixed income, we prefer credit to Treasuries. We would also consider an allocation to Treasury inflation protected securities (TIPS) where appropriate.

Portfolio repositioning is likely to continue well into 2017, as developments unfold and the pro-cyclical environment gathers momentum. With growth already heading higher from Q3 2016 onward and earnings turning positive, investors have begun increasing cyclicality and exposure to value in portfolios at the expense of more defensive sectors and higher-dividend areas within equities. In addition, we expect a larger shift in emphasis toward small capitalization, which has already started, and more domestic-oriented equities due to a slightly stronger dollar, more pro-growth policies and the desire for a hedge against potential retaliatory trade policies from main

trading partners. This portfolio shift in positioning is happening but, in our view, is in its early stages.

We have moved from a "get paid to wait" core portfolio theme to a more cyclical and value-oriented theme in multi-asset and all-equity portfolios primarily due to increased business and consumer confidence, which should lead to higher earnings than originally expected.

- Therefore, we have raised our exposure to equities versus fixed income to a moderate overweight and our new tactical asset allocation view is overweight equities versus its strategic benchmark.
- We are now further underweight fixed income versus equities, underweight versus its strategic benchmark rather than neutral, and have lowered cash to neutral from overweight.

Within the asset classes, we have made a number of changes consistent with our view from earlier this year and one that has accelerated post-election.

- We are now moderately overweight U.S. small capitalization equities and neutral non-U.S. developed markets.
- We maintain our preference for U.S. high-quality large caps and continue to overweight emerging markets.
- We continue to favor value over growth and more cyclical areas (such as financials and consumer discretionary) versus defensives (such as utilities and consumer staples).

In fixed income, we have moved from a balanced view to a larger underweight versus the strategic benchmark.

- However, fixed income still represents an important portfolio diversifier—and a volatility dampener in unforeseen worst-case scenarios—and should be viewed primarily as a cash flow producer versus a total return asset, given the expectations for higher yields.
- In addition, we have lowered Treasuries to a further underweight but maintain our neutral rating on high yield and underweight on international fixed income.
- Municipal bonds have corrected to levels that are becoming attractive again, and we are still favorable on investment grade corporate credit.
- We maintain our neutral rating on real estate and commodities, but we prefer metals and oil to gold.

In addition, the pro-cyclical improvement has started to break down the elevated correlation among and within asset classes since earlier in 2016. We expect this adjustment to continue in 2017 as economic volatility picks up and asset class volatility follows suit. Transitions to late-cycle phases tend to invite a higher level of volatility as inflation rises and central bank policies shift to nudging short rates higher.

In this environment, alternative investments, namely hedge funds, should outperform industry benchmarks, in contrast to recent underperformance. For investors able to withstand a higher allocation of illiquid assets in their portfolio, we prefer timberland for its long term-growth prospects and low correlation to financial assets.

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Outlook

Goldman Sachs

Investment Management Division

Half Full

"Everything we hear is an opinion, not a fact. Everything we see is a perspective..."

Attributed to Marcus Aurelius

Investment Strategy Group | *January 2017*

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Dear Clients,

Readers of our previous *Outlook* publications may recall that this page typically summarizes the key themes of our economic and financial market prospects for the coming year. However, for 2017 we decided that a brief overview would not suffice, given the current environment of high market valuations, great policy uncertainty, significant geopolitical tensions and, in all likelihood, an unconventional US presidency.

Since the trough of the global financial crisis, we have consistently emphasized US preeminence and maintained a strategic overweight to US equities relative to global market capitalization-weighted benchmarks. Tactically, we have had an overweight allocation to US equities and US high yield bonds from as early as mid-2008. Even when US equities became more expensive, we continued to recommend that clients stay fully invested at their strategic allocations. Indeed, we have reiterated that recommendation in our past *Outlook* publications, client calls and *Sunday Night Insight* reports as many as 59 times since January 2010.

But now we have crossed into the 10th decile of valuations: US equities have been more expensive than current levels only 10% of the time in the post-WWII period. Yet we continue to recommend staying the course. We are duly aware that this recommendation is long in the tooth, particularly given such high valuations and the unusually high level of policy uncertainty.

Policy uncertainty, both economic and political, abounds globally: uncertainty with respect to Brexit (the how and when), upcoming elections in Germany and France (the who), transitional government in Italy (the how long followed by what) and new appointments to the Standing Committee in China and their significance (the who and what of any reform agenda), to name a few.

We are also facing rising geopolitical tensions that could trigger significant market volatility. Tensions in the Middle East will not abate. Greater Russian involvement in that region is stabilizing in some respects and destabilizing in others. Further Russian incursions into Eastern Europe may elicit a more robust reaction from the West. Terrorism could spread in the US and Europe as ISIL (Islamic State of Iraq and the Levant) loses territory in Iraq and Syria and foreign fighters return home. North

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Korea's nuclear program and missile launches go unchecked. There is rising risk of military incidents—or accidents—in the South China Sea and across the Taiwan Strait.

China is the most likely source of global economic shocks over the next two to three years. The country's leadership continues to prioritize imbalanced economic growth over structural reforms, thereby increasing debt at an unsustainable pace. Such increases will eventually prove to be destabilizing.

In Donald Trump, the US has elected an unconventional president in many respects, including his more US-centric approach to China. If China responds to, say, imposition of US tariffs on imports of Chinese products by sharply devaluing the renminbi, significant downside volatility and tighter global financial conditions will follow.

Given already high US equity valuations, uncertain economic and political policy prospects and heightened geopolitical risks, readers may well ask why we continue to recommend staying fully invested in US equities. Among the reasons:

- Our eight-year US preeminence theme is intact and continues into its ninth year. As Professor Jeremy Siegel of the University of Pennsylvania wrote 23 years ago in *Stocks for the Long Run*[1] and recently repeated in a *Wall Street Journal* interview,[2] "Stocks are the best long-run asset." We refine that view by saying US equities are the best long-run asset.
- We think that the policy backdrop in the US will be particularly favorable for the economy, with looser fiscal policy, relatively easy monetary policy and a less stringent regulatory environment. We expect US growth to continue through 2017.
- We expect global growth to improve modestly, from 2.5% in 2016 to 2.9% in 2017, with looser fiscal policy and still easy monetary policy in key countries.
- And last but not least, we expect that while President-elect Trump's initial policy measures with respect to tariffs and trade agreements risk jolting financial markets, as a self-described "deal maker" he will likely adjust and change course as necessary to achieve his desired results.

We may have a bumpy ride, but the US economy will not be derailed.

Over the years, we have viewed the glass as half-full—if not full—when it comes to the US economy. Many others have seen the glass as half-empty, pointing out that productivity growth has decreased, US labor demographics are less favorable and government policies have been ineffective. While it is correct that productivity growth has decreased and labor demographics are less favorable, it does not follow that the US economy is in stagnation. Quite the reverse.

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We should note that our conviction in US preeminence and US economic growth in 2017 is greater than our conviction in the direction of the equity markets. Just as we were appropriately humble about how much further equity markets could fall when we published our 2009 *Outlook*, we are equally humble today about our financial market outlook given the significant uncertainties ahead.

Here, we are reminded of Voltaire's famous words: "Doubt is not an agreeable condition, but certainty is an absurd one." A client with a well-diversified portfolio that is fully invested at its US equity allocation is generally well positioned for these uncertain and probably volatile times.

We hope our 2017 *Outlook* is helpful as you evaluate your portfolio allocations. We also wish you a healthy, happy and productive 2017.

The Investment Strategy Group

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We expect a favorable global economic and policy backdrop in 2017, but there is no shortage of risks. We recommend clients stay invested in US equities with some tactical tilts to US high yield and European equities.

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Half Full

Since the trough of the global financial crisis in March 2009, US equities have returned nearly 300%, producing one of the longest bull markets in the post-WWII period and outperforming all other major developed and emerging market country equities. US equities have also exceeded their pre-crisis peaks of October 2007 and March 2000 by 75% and 103%, respectively, on a total return basis. This bull market has exceeded all other bull markets but one in length and exceeded all but three in magnitude.

US economic growth has also exceeded that of most other recoveries in length. This recovery is the fourth-longest recovery in the post-WWII period[3] and if, as we expect, the US economy avoids a recession in the first half of 2017, this recovery will become the third-longest. While many critics correctly point out that it is the slowest recovery since WWII, it has actually created more economic growth than some of the stronger recoveries that lasted for shorter periods. On a cumulative basis, this recovery ranks sixth out of the last 10 recoveries with respect to GDP growth. What this recovery has lacked in strength, it has partially made up for in length.

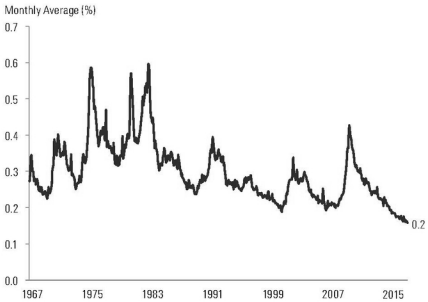
The slow but steady growth has also exceeded that of all other major developed economies, and US GDP per capita has increased more than the GDP per capita of any major developed or emerging market country.

This recovery has created over 15 million jobs. The unemployment rate decreased from a peak of 10.0% in October 2009 to 4.6% in November 2016 and is now below its long-term average of 5.8%. Even the broader U6 measure, which adds the underemployed (such as part-time and discouraged workers) to the number of unemployed, has fallen from a peak of 17.1% to 9.3%, and stands below its long-term average of 10.6%. Unemployment claims are not only lower than they were during pre-crisis troughs but also at their lowest since 1973; they are also the lowest on record as a percentage of the labor force (see Exhibit 1).

As a result of more robust employment, wages have increased as well. Wage growth, as measured by the Atlanta Federal Reserve Bank Wage Growth Tracker (which, in our opinion, is a better gauge of the employment backdrop than average hourly earnings, since it is not affected by the changing composition of the labor force as new entrants are hired at lower wages), has picked up from a low of 1.6% year-over-year growth in May 2010 to a high of 3.9% in November 2016—just below the 4.4% peak of September 2007. More robust employment and better wage growth have, in turn, led to a steady increase in consumer confidence, reaching levels last seen in August 2001, as measured by the

Exhibit 1: US Initial Unemployment Claims as a Share of the Labor Force

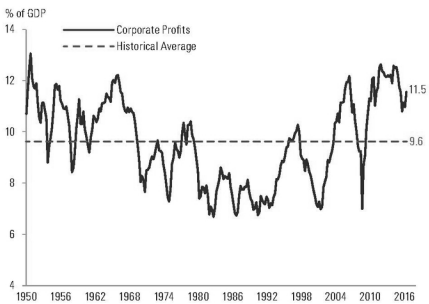
Claims as a share of the labor force are at record lows.



Data through December 2016.
Source: Investment Strategy Group, Datastream.

Exhibit 2: Corporate Profits as a Share of US GDP

Profits have been higher than current levels only 17% of the time since 1950.



Data through Q3 2016.
Note: Showing US corporate profits with inventory valuation adjustment and capital consumption adjustment.
Source: Investment Strategy Group, Datastream.

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The Declinists at Work

March 1979
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July 2016
Source: *Financial Times*. Martin Wolf/James Ferguson, 2016. "Global elites must heed the warning of populist rage." *Financial Times* / FT.com, 20 July. Used under licence from the *Financial Times*. All Rights Reserved.

Conference Board. Even median household income, as measured by the US Census Bureau, rose in 2015 at the fastest rate on record.

In the corporate sector, total profits of domestic corporations as a percentage of GDP, as measured by the national income and product accounts (NIPA), are close to all-time highs. At 11.5% of GDP, profits not only are well above the historical average of 9.6%, but have been higher than current levels only 17% of the time since 1950, as shown in Exhibit 2.

Despite these "glass half-full" facts, the announcements of US decline that pervaded the airwaves in the depths of the global financial crisis have persisted. We continue to be inundated with analysis of "America's relative decline,"[4] "America's slow-growth tailspin" and "sclerotic growth,"[5] "an economic in-tray full of problems"[6] and, of course, "secular stagnation."[7] Two books published in 2016 that have received extensive coverage epitomize the sentiment: Robert Gordon's *The Rise and Fall of American Growth*[8] and Marc Levinson's *An Extraordinary Time: The End of the Postwar Boom and the Return of the Ordinary Economy*.[9]

Some of the images are equally telling. We were struck by a recent image of the Statue of Liberty on its side that resembles a *Business Week* cover of March 1979 with a tear trickling down Lady Liberty's face. Since WWII, the waning of US preeminence has been a topic of recurrent hand-wringing. Whether prompted by the flexing of Soviet muscle, most spectacularly with the launch of Sputnik in the 1950s; the civil rights upheavals and growing fallout from the Vietnam War in the 1960s, the Arab oil embargo and the Watergate scandal of the 1970s, the rise of Japan in the 1980s or the rise of China in the 2000s, the declinists have foretold the ebbing of American preeminence. Typical of the genre is a 2009 book provocatively titled *When China Rules the World*[10] by British columnist Martin Jacques.

Yet, as we wrote in our 2011 *Outlook: Stay the Course*, neither the global financial crisis nor the rise of China will hinder what we described as "America's structural resilience, fortitude and ingenuity" and remove the US from its preeminent perch.

What explains our difference of opinion, which has consistently underpinned our investment recommendation for a greater allocation to US assets and for remaining invested at such high valuations? Why do we believe that the US is on a more solid footing both absolutely and relative to all other major countries in the world? Is it a matter of perspective, analytical rigor, bias, review of longer economic history, or reliance on a big cadre of external experts in specialized fields?

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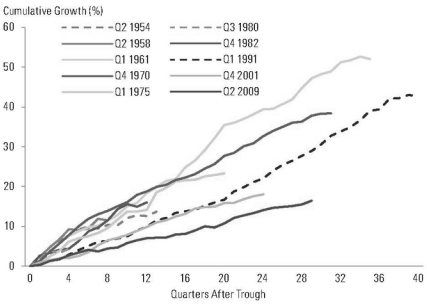
Exhibit 3: Growth in US Real GDP Across Post-WWII Expansions

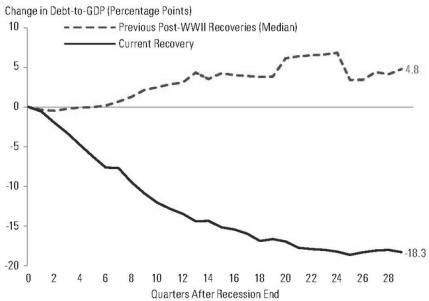
In this recovery, GDP has grown at half the average pace of prior expansions.



Data as of Q3 2016.
Source: Investment Strategy Group, Datastream, National Bureau of Economic Research.

Exhibit 4: Change in US Household Leverage Following Recessions

A large reduction in household debt served as a drag on the pace of this recovery.



Data through Q3 2016.
Source: Investment Strategy Group, National Bureau of Economic Research, Federal Reserve Economic Data.

We believe that no one factor explains the difference in opinion. Instead, we rely on a comprehensive framework of investigation that blends all of these elements, combining rigorous fundamental, quantitative and technical analysis, as well as the insights of an extensive network of external experts. At the same time, we continually endeavor to overcome the behavioral biases Nobel Laureate Daniel Kahneman and his collaborator Amos Tverksy have shown to affect economic decision-making and tolerance for risk. These key characteristics of our investment process not only underpin our continued view of US preeminence, but also allow us to form a holistic view across global economies and asset classes. Of equal importance, our framework provides us with a consistent process by which to assess investment opportunities. While we believe our approach is robust, we acknowledge that nothing can ensure we will avoid the next downdraft.

We begin our *Outlook* with a brief review of this recovery and place it in the context of past recoveries showing that the glass is indeed half-full. We address some of the key concerns regarding demographics and declining productivity growth. We show that US labor force demographics have deteriorated and will continue to do so, especially in the absence of policy changes. Nonetheless, we demonstrate why there is room for optimism about productivity growth. The analysis leads us to a view of slightly above-trend growth for 2017 with some upside potential from higher productivity and fiscal stimulus from a Trump administration.

We then turn to our one- and five-year expected returns, which are driven by our view of a solid economic foundation, a well-balanced economy and a positive growth trajectory in the US. We conclude our introductory section with the risks to our view, both upside and downside, including a low probability of recession in 2017, high policy uncertainty under a Trump administration, possible global shocks from economic and currency policies in China, and the risks of geopolitical mishaps in Europe, the Middle East and the Far East.

This Recovery in Context—An Update

This recovery has been the slowest of the 10 recovery cycles since WWII, as shown in Exhibit 3. Since the trough, US GDP has grown at an annualized rate of 2.1% through the third quarter of 2016, which is half the pace of the median and average growth rates of all other recoveries. The slow GDP growth rate stands in stark contrast to the recovery in the labor market and, most recently, in wages and household income. Impressively, the decline in the unemployment rate has been the second-largest of all post-WWII recoveries.

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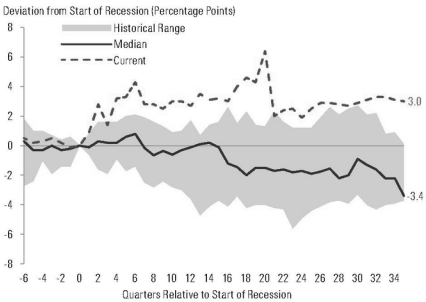
Exhibit 5: Change in US Personal Savings Rate Surrounding Historical Recessions

The increase in the personal savings rate in this recovery has been unusually large.



Data through Q3 2016.
Note: Quarter 0 marks the start of each recession since 1950, defined as the NBER recession cycle start. The cycle is measured from the start of each recession until the beginning of the next recession.
Source: Investment Strategy Group, Datastream, National Bureau of Economic Research.

Exhibit 6: Ratio of US Household Net Worth to Disposable Income

Real estate price and financial asset gains have boosted the ratio to near pre-crisis highs.

Data through Q3 2016.
Source: Investment Strategy Group, Datastream.

The anemic (but steady) pace of this recovery has fueled a debate about its causes. The theories fall into six categories:

- A "hangover" from the global financial crisis[11]
- "Secular stagnation" due to unfavorable demographics
- "Secular stagnation" due to declining productivity growth
- Mismeasurement of GDP statistics
- Poor policies in Washington
- A steady onslaught of external shocks

We briefly examine each of these six theories below—some of which we have touched upon in our prior *Outlook* publications. While there has been further research on the topic over the past year, the debate has not yet been resolved and likely never will be to everyone's satisfaction. One star-studded group of experts believes that most contributing factors other than weaker demographics have dissipated or will dissipate, and the US economy will remain structurally vibrant. Another star-studded group believes that the best days of the US are behind it, contending that even radical policy changes will not reverse this decline and that the 2016 election results are a testament to this "secular stagnation."

A Hangover from a Crisis

Proponents of the "hangover" theory suggest that recoveries after a major financial crisis generally have been slower. In their book, *This Time Is Different: Eight Centuries of Financial Folly*,[12] Carmen Reinhart and Kenneth Rogoff use historical data from 66 countries between 1810 and 2010 to demonstrate that, historically, recoveries following a major financial crisis have been markedly slower than other recoveries.

Fundamentally, one can argue that households deleverage for a long time to increase precautionary savings, and corporations limit capital expenditures to build up precautionary cash, out of fear that another major financial crisis is looming. As shown in Exhibit 4, the pace at which households deleveraged in this most recent crisis was faster than in any other recovery in the post-WWII period; commensurately, the increase in the personal savings rate since the start of the recession is unusually large relative to previous cycles (see Exhibit 5).

Along with higher savings, the increase in home prices to levels matching the February 2007 peak (as measured by the S&P/Case-Shiller US National Home Price Index on a seasonally adjusted basis) and the appreciation in financial assets have boosted the ratio of household net worth to disposable income to near pre-crisis levels, as

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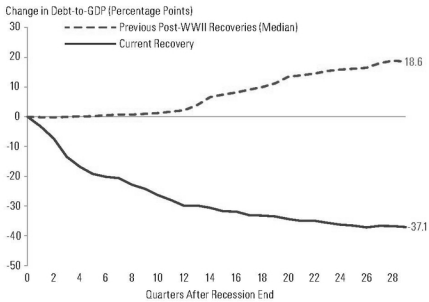
shown in Exhibit 6. This improvement in net worth will enable households to lower their savings rates going forward and support consumption. Therefore, even if the "hangover" hypothesis was partly valid earlier in the recovery, it should have less impact in the future.

During the current recovery, the financial sector also deleveraged substantially, partly due to the unusually high levels of leverage that existed as the crisis began and partly due to greater financial regulation resulting from the Dodd-Frank Wall Street Reform and Consumer Protection Act signed into federal law by President Barack Obama on July 21, 2010. As shown in Exhibit 7, the financial sector began to deleverage even before Dodd-Frank and has continued to do so through 2016.

However, more recently, the pace of deleveraging has abated, as shown in Exhibits 4 and 7. Furthermore, such deleveraging may well be bottoming and soon reverse as households and the financial sector face a more favorable fiscal and regulatory policy environment under President-elect Trump. For all practical purposes, the "hangover" may now be over.

Exhibit 7: Change in US Financial Sector Leverage Following Recessions

A decrease in financial sector indebtedness has contributed to a slower-than-usual recovery.



Data through Q3 2016.
Source: Investment Strategy Group, National Bureau of Economic Research, Federal Reserve Economic Data.

Secular Stagnation: Unfavorable Demographics

As we discussed in our 2016 *Outlook: The Last Innings*, the term "secular stagnation" was first coined by economist and Harvard professor Alvin Hansen in 1934[13] and fully described in his presidential address to the American Economic Association in 1938.[14] He predicted that poor demographics, limited innovation and few trading and investment opportunities would slow US growth.

The term was more recently popularized by Lawrence Summers, professor at Harvard University and former secretary of the Treasury, when he referred to secular stagnation in a 2013 speech at the International Monetary Fund.[15]

Hansen's dire predictions never came to pass, and the US experienced close to record levels of productivity growth in the post-WWII period up to 1973, along with strong growth in the labor force. This current cycle, in contrast to the decades immediately following Hansen's predictions, has been hampered by weak demographics and a decline in the growth rate of the labor force. In a September 2016 study, aptly called "How Should We Think About This Recovery?," Jay Shambaugh, a member of the Council of Economic Advisers, shows that when one compares this recovery with the average of past recoveries, the growth gap narrows significantly if one accounts for the number of people in the labor force.[16] Instead of this recovery growing at about half the pace of the average of past recoveries, the gap narrows to 83% of the average: GDP per number of people in the labor force has grown at an annualized rate of 1.9%, compared with an average of 2.3% in past recoveries. A recovery that appears to be at half the pace of other recoveries is actually in line with other recoveries after adjusting for the size of the labor force, as shown by comparing the red lines in Exhibits 8 and 9.

There are two components to the unfavorable demographics story. The first is simply the decline in the growth rate of the US working-age population, which is driven by aging, the retirement of the baby boom generation and slower immigration.

This trend cannot be easily reversed; however, the pace of decline can potentially be slowed. For example, the commonly accepted retirement age of 65 can be extended. In fact, there is some evidence that baby boomers are working longer than historical norms.[17] When life expectancy was about 62 years in 1935, the retirement age for Social Security was 65. Today, life expectancy in the US is about 79 years, and the retirement age for Social Security has been extended to 67 for those born in 1960 or later. Of course, more broadly, the retirement age is still regarded as 65. A 65-year-

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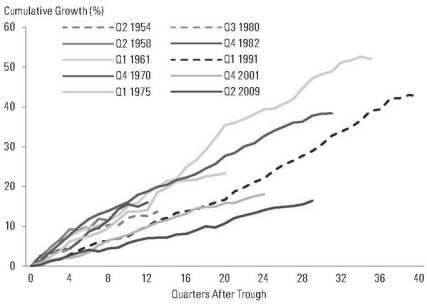
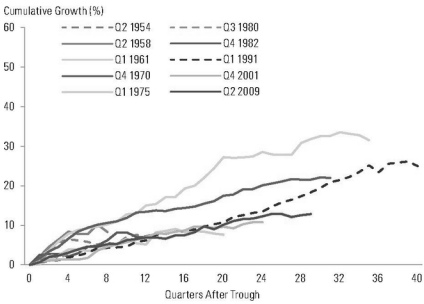
Exhibit 8: Growth in US Real GDP Across Post-WWII Expansions
In this recovery, GDP has grown at half the average pace of prior expansions.



Data as of Q3 2016.
Source: Investment Strategy Group, Datastream, National Bureau of Economic Research.

Exhibit 9: Growth in US Real GDP per Person in the Labor Force Across Post-WWII Expansions
But when adjusted for labor force trends, this recovery has actually been in line with the average of past expansions.



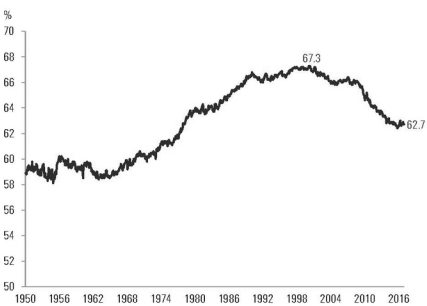
Data through Q3 2016.
Source: Investment Strategy Group, Datastream, National Bureau of Economic Research.

old today, however, is much healthier and more vibrant than a 65-year-old in 1935 and has many more years of active life that can reduce the decline in the growth rate of the working-age population. Furthermore, this cohort is quite productive relative to new entrants into the labor force. Similarly, immigration reform can help offset the decline in working-age population growth. Both factors depend on policy changes, and we do not have any definitive reason to be either optimistic or pessimistic at this time.

The second component of the unfavorable demographics perspective has been the drop in labor force participation, particularly among males. Exhibit 10 shows the rapid growth in labor force participation that occurred as the baby boom generation reached working age and as women joined the labor force in growing numbers after 1950. The labor force participation rate, however, peaked in 2000 and declined by 0.3% a year until it troughed at 62.4% in September 2015. Most of the drop was driven by three factors: significant decline in male labor force participation, retirement of baby boomers and the cyclical decline in demand for labor as a result of the global financial crisis. Some of the cyclical decline reversed as the economic recovery entered its eighth year: the participation rate has risen to 62.7% as of November 2016.

The male labor force participation, however, has been declining, coincidentally also by 0.3%

Exhibit 10: US Labor Force Participation Rate
Both cyclical and structural factors have contributed to a decline in the participation rate from the 2000 peak.



Data through November 2016.
Source: Investment Strategy Group, Datastream.

per year—but since 1952. The trend has occurred across all age cohorts. An important driver of this decline has been reduced demand for lower-skilled and less-educated males. The US ranks 32 out of 34 OECD countries in participation of prime-age (between the ages of 24 and 54) males in the labor force, ahead of only Italy and Israel.[18] A Council of Economic Advisers report in June 2016 attributed that low ranking to the fact that the US spends less than other OECD countries on job search

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assistance and job training, and to the fact that the US has a high rate of incarceration that especially affects lower-skilled men.[19] According to the report, several policy measures can boost prime-age male labor force participation, including

- Increased investment in infrastructure
- Systemic reforms in the criminal justice system and in immigration policies
- Tax reforms
- Investment in education and training

This demographic aspect of secular stagnation is undeniable. In fact, an October 2016 paper by a team at the Federal Reserve Board, "Understanding the New Normal: The Role of Demographics,"[20] shows that the slow pace of economic growth since 1980 and the more pronounced decline in the last decade could be predicted by a model looking at "fertility, labor supply, life expectancy, family composition, and international migration."

Thus, a glass half-full or half-empty perspective does not change the facts on the ground. There is little cause for near-term optimism with respect to the slower growth rate of the labor force. The general consensus is that the US labor force will grow at an average of 0.6% per year in the next several decades, compared with 1.6% from 1950 to 2000.[21]

In the shorter term, infrastructure investment and other policies highlighted above may boost the growth rate in the labor force, but it is hard to imagine growth rates reaching levels that would support President-elect Trump's GDP growth targets of 3–4% on a sustainable basis.[22]

Secular Stagnation: Declining Productivity Growth

Of all the theories put forth to explain the slow pace of this recovery, the one that has garnered the most attention is declining productivity growth. It is also the most important issue in terms of its impact on future trend growth in the US, which in turn has the greatest impact on the long-term rate of earnings growth and equity market returns.

As reviewed in last year's *Outlook*, the techno-optimists and the techno-pessimists are on opposite sides of the debate on declining productivity growth. Both camps have garnered new members; even Federal Reserve Chair Janet Yellen and Vice Chair Stanley Fischer have joined the fray.[23] Most recently, in September 2016, the Brookings Institution hosted a conference with leading experts from both camps to debate the issue.

We should note that debates on productivity are nothing new. They have surfaced during past periods of slow growth, as was the case in the early 1990s. Even some of the players are the same: Robert Gordon was a techno-pessimist in the early 1990s and remains so in the 2010s.[24]

Part of the productivity debate is philosophical. For example, one question pertains to the increased use of free digital services such as Facebook, Google Maps, Waze and Khan Academy. These services yield "consumer surplus," defined as the benefits consumers derive from various activities over and above the price they pay. Should they be included in GDP if they are deemed "non-market" services—those that are provided free of charge or at a fee that is well below 50% of production costs? While social media such as Facebook may (or may not, depending on your perspective) provide a service greater than the advertisement revenues associated with the use of that service, some will argue that if such services do not have an associated market price, they are not part of GDP and therefore should not impact the calculation of productivity levels. As the volume and the impact of these non-market services increase, we believe that the methodology for measuring GDP will evolve to better reflect the value of these services.

Such improvements in measuring GDP are not uncommon. The Bureau of Economic Analysis (BEA) conducts comprehensive revisions of the national income and product accounts every five years, with the goal of reflecting methodological and statistical improvements. Most recently, in 2013, the BEA expanded its definition of fixed investment to include expenditures on research and development and expenditures on artistic originals (e.g., books, music, television

Of all the theories put forth to explain the slow pace of this recovery, the one that has garnered the most attention is declining productivity growth.

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Exhibit 11: Pillars of the Investment Strategy Group's Investment Philosophy

series, movies). Combined with some smaller improvements, these changes added $560 billion to the level of 2012 GDP, a 3.6% increase relative to the prior estimate.[25]

The more immediate—and important—question is whether we have entered a new phase in productivity growth trends that will keep productivity growth at the low levels seen since 2004. We believe that the answer is unknowable with any degree of certainty; historically, productivity forecasts have been notoriously wrong. In *The Age of Diminished Expectations*,[26] first published in 1990, Paul Krugman, Nobel laureate in economics and professor at City University of New York, wrote that the lower pace of productivity growth experienced since the early 1970s would most likely persist in the future. In 1995, however, productivity growth rates increased and were more than double the rate of the prior 12-year period.

Similarly, in 1997, the Congressional Budget Office estimated that the long-run average annual growth rate of labor productivity would be 1.1%. Between 1995 and 2004, the actual average annual growth rate of labor productivity was 3.2%.[27]

As many of our clients know, one of the pillars of our investment philosophy is that history is a useful guide (see Exhibit 11). And history tells us that labor productivity has moved in cycles, with periods of low productivity growth followed by periods of high productivity growth. In a forthcoming and comprehensive paper titled "Seven Reasons to Be Optimistic About Productivity,"[28] Professors Lee Branstetter of Carnegie Mellon University and Daniel Sichel of Wellesley College show that periods of low productivity growth have been followed by periods of high productivity growth since 1889, as seen in Exhibit 12. There is no reason to believe that "this time is different"; as many of you also know, we believe that those words are among the most dangerous and misused words in our industry.

Olivier Blanchard, senior fellow at the Peterson Institute for International Economics and former chief economist at the IMF, has also shown that the current period of low productivity growth does not tell us much about future productivity trends. He states that the correlation of "successive pairs of five-year averages of total factor productivity growth is only 0.20" since the mid-1970s.[29]

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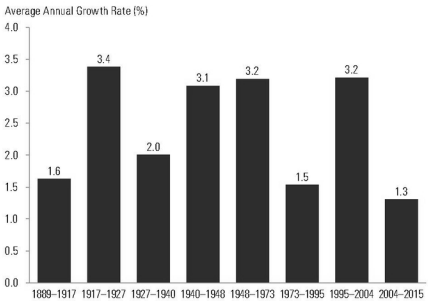
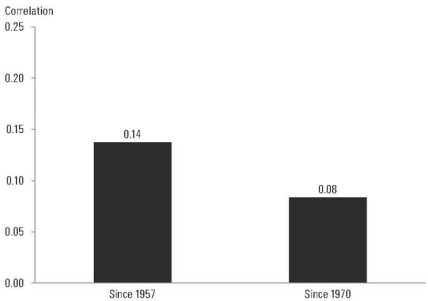
Exhibit 12: US Labor Productivity Growth
Periods of slow productivity growth have been followed by periods of stronger productivity gains.



Data through 2015.
Source: Investment Strategy Group, Lee Branstetter and Daniel Sichel, "Seven Reasons to Be Optimistic About Productivity," forthcoming Peterson Institute for International Economics Policy Brief.

Exhibit 13: Correlation of 5-Year US Productivity Growth Rates With Following 5 Years' Productivity Growth Rates
Recent productivity trends tell us little about the future.



Data through Q3 2016.
Source: Investment Strategy Group, Haver Analytics, Olivier Blanchard, "Three Remarks About the US Treasury Yield Curve," Peterson Institute for International Economics, June 22, 2016.

We have examined labor productivity growth rates and, as shown in Exhibit 13, find even lower correlations.

There are two issues to consider. First, if the reported productivity growth rates are accurate, then the exceptionally low rates of the last 10 years account for part of the slow pace of this recovery. However, the current low productivity growth rates do not portend low growth rates going forward. Just as Hansen was proven wrong on his secular stagnation theory and Krugman was proven wrong on his diminished expectations for the US economy (and they were both influenced by their pessimistic view on productivity), those who extrapolate stagnation from the current productivity trends may be proven wrong as well.

Second, as we discuss below, there is also a high probability that real GDP may be mismeasured. If real GDP is mismeasured, it follows that productivity is also mismeasured, thereby invalidating the whole theory of secular stagnation and the decline of the US economy.

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Mismeasurement of GDP Statistics

In addition to the productivity debate, there is a debate as to whether we are measuring GDP correctly in the first place. The key argument being made is that while we correctly measure the value of *nominal* GDP based on the value of goods and services, we mismeasure the value of *real* GDP when we convert nominal GDP to real GDP using various price indices, and this therefore understates the pace of this recovery. This debate garnered considerable attention in 2016.

The mismeasurement argument states that the official price indices do not adequately reflect significant improvements in many products, especially in information and communication technology, due to the methodology used by the Bureau of Labor Statistics (BLS) and the BEA. If the price indices do not adequately reflect the greater capacity of an improved product such as a smartphone or a microprocessor, then the price index used to convert nominal GDP to real GDP is too high. And if the price index is too high, then real GDP is understated.

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It follows that if real GDP is understated, then what appears to be a slow recovery is not as slow as reported and what appears to be a period of low productivity growth is not as low as reported.

We believe that the evidence favors the mismeasurement argument. At a September 2016 Brookings Institution conference on productivity, Martin Feldstein, Harvard professor and president emeritus of the National Bureau of Economic Research, also concluded that "the official statistics substantially underestimate the real growth of output" after studying the methods used to measure price indices.[30]

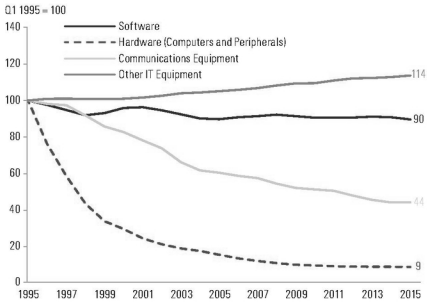
We point to three examples to illustrate the mismeasurement argument. First, our colleagues in Goldman Sachs' Global Investment Research (GIR) have pointed out that the official price indices for information and communication technology show an implausible gap between the price deflation in computers and that in communications equipment, software and other IT equipment (see Exhibit 14). They question how "a given dollar outlay now buys about 10 times as much computer in real terms as 20 years ago, but it only buys about 10% more software."[31]

Our colleagues' conclusion that the official price indices for the information and communication technology sector are overstated matches that of a 2015 study of microprocessor pricing by David Byrne of the Federal Reserve Board, Professor Stephen Oliner of UCLA, and Sichel.[32] The trio created an index showing that prices for microprocessor units used in desktop personal computers declined by an average annual rate of 43% between 2008 and 2013, while the official Producer Price Index (PPI) for these units declined by an average annual rate of 8%—substantially mismeasuring the real value created by this sector of information technology equipment. They point out that because microprocessor units represent about half of US shipments of semiconductors, the rate of innovation in this sector is inevitably mismeasured.

A second example of mismeasurement that we can all readily appreciate involves the quality and product improvements in smartphones. Hal Varian, chief economist at Google and emeritus professor at the University of California at Berkeley, has estimated that globally, people took over 1.6 trillion photos in 2015 using their smartphones, compared with 80 billion in 2000 using cameras and film. The price of each photo taken has gone

Exhibit 14: US Technology Price Indices

The implausible gap with hardware suggests IT and communication price indices are likely overstated.



Data through 2015.
Note: Other IT Equipment represents medical and non-medical equipment and instruments.
Source: Investment Strategy Group, Goldman Sachs Global Investment Research, Bureau of Economic Analysis.

from 50 cents to zero for smartphone users; 1.6 trillion photos that would have contributed $800 billion to GDP have no impact on GDP in the current framework. GDP has declined since camera and film sales have fallen without a commensurate quality adjustment for smartphones. Of course, fewer photos would have been taken had the smartphone not been developed, but the point still stands.[33]

Similarly, Varian shows that with the onset of the commercial application of GPS technology, productivity growth in trucking was twice the aggregate US productivity growth, yet when GPS functionality was added to smartphones basically at no additional charge, GDP declined because sales of stand-alone GPS systems fell.[34]

Finally, a third example, also provided by Varian, shows that, because GDP does not fully count the export of intangibles such as software and design, GDP is understated. He shows how an iPhone manufactured by Foxconn in China using parts from 28 countries and exported to France has no direct impact on US GDP. Varian concludes that in a global supply chain, US design and software that is replicated outside the US through offshore manufacturing and exported to a third country never impacts US GDP measures directly, particularly if the profits are not repatriated and redeployed in the US.[35]

Our colleagues in GIR continue to estimate that such mismeasurements lower reported annual real

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We believe that productivity in health care is underestimated. Consider IBM's Watson Health, an artificial intelligence system that can read 200 million pages of text in 3 seconds. As of 2015, Watson had amassed 315 billion data points representing health records, lab results, genomic tests and clinical studies. The system processes patients' cases against its ever-growing database and recommends customized treatment options. With such developments, we expect continued improvement in growth of productivity in health care.

"If productivity growth were better measured, particularly in health and other services, the growth rate would look better than is currently reported."

Martin Neil Baily and Nicholas Montalbano, "Why Is U.S. Productivity Growth So Slow? Possible Explanations and Policy Responses," Brookings Institution, September 2016.

GDP growth by about 0.7 percentage point, similar to their estimate reported in our *Outlook* last year.

Of course, not all experts believe that there is a mismeasurement problem. Notable among them is Chad Syverson of the University of Chicago, who raises four points in making this case.[36] First, he states that the productivity slowdown has been global in nature and unrelated to countries' consumption or production intensities of information and communication technology. Second, he states that estimates of consumer surplus are too small relative to his estimates of lost GDP due to slower productivity growth. Third, he argues that if such mismeasurement existed, the growth rate in the information and communication technology sector would be a multiple of its stated growth rate. Finally, while he acknowledges that gross domestic income has been higher than GDP since 2004 and the gap might reflect the higher wages of workers who are producing non-market digital services, he does not believe that this difference is evidence of mismeasured GDP because the trend started earlier than the slowdown in productivity growth.

A somewhat similar line of reasoning has been presented by Byrne, John Fernald of the Federal Reserve Bank of San Francisco and Marshall Reinsdorf of the IMF in a paper titled "Does the United States Have a Productivity Slowdown or a Measurement Problem?"[37] While they agree that productivity growth has been mismeasured in the past, they argue that the mismeasurement has been negligible in the 2004–15 period partly because computer hardware, for which mismeasurement was once a factor, now makes up a smaller part of GDP. Therefore, the impact is less in the 2004–15 period than it was in the 1995–2004 period when productivity growth was much higher. They also state that free digital products not only are non-market and should not be counted in GDP, but also are not sizable enough to account for the level of decline in productivity growth rates.

Experts' opinions on mismeasurement continue to evolve. In fact, in a subsequent publication co-authored with Carol Corrado of the Conference Board, Byrne found a significantly higher level of software price mismeasurement than assumed in his prior paper.[38] He has also co-authored a study on prices and depreciation for computer tablets such as iPads, proving that quality-adjusted price indices for tablets have fallen much faster than the broader price indices for computers and peripheral equipment.[39]

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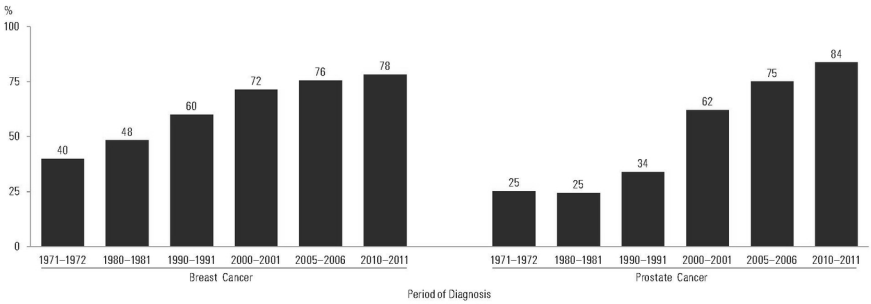
Exhibit 15: 10-Year Net Survival Rate of Breast and Prostate Cancer Patients

Improved cancer survival rates reflect significant gains in science and technology.



Data as of November 2014.
Note: Based on cancer statistics for the UK. Ten-year survival for 2005–2006 and 2010–2011 is predicted using an excess hazard statistical model.
Source: Investment Strategy Group, Cancer Research UK.

We conclude that there is undoubtedly some degree of mismeasurement. We know that information and communication technology has evolved significantly and innovation is occurring at a rapid pace. We know that the BEA reviews its statistical methodologies every five years and revises them as needed, recognizing that measurement methodologies have to evolve with the evolution of the US economy. We also know that we as consumers carry incredibly powerful digital equipment in the palms of our hands and pay less for it than we paid for equipment with lesser functionalities not so long ago. Common sense supplemented by extensive research by the experts on productivity and mismeasurement reinforces our view of a glass half-full when it comes to innovation and productivity in the US.

We realize this debate will be resolved only with the benefit of hindsight, in the same way that realized productivity growth exceeded the prognostications of Hansen in the late 1930s and Krugman in the early 1990s. Our clients will be inundated with conflicting views from headlines in the media and books with captivating titles. Separating fact from fiction remains challenging. Recently, an article in the *Wall Street Journal* highlighted "dwindling gains in science, technology and medicine."[40] The article suggested that improvements in breast cancer mortality have slowed since 1985. Exhibit 15 shows the 10-year net survival rate for breast cancer and prostate cancer since 1971. Maybe it is only a matter of perspective, but, to us, a 78% 10-year survival rate for breast cancer and an 84% 10-year survival rate for prostate cancer represent significant improvements over the rates of the early 1980s, 48% and 25%, respectively, and are even more significant for those whose lives have been saved.

Probably one of the more amusing instances of conflicting perspectives can be seen in the 2016 publication of two books with diametrically opposed messages: *Progress: Ten Reasons to Look Forward to the Future*[41] and *The Innovation Illusion: How So Little Is Created by So Many Working So Hard*,[42] both written by authors born in Sweden in the early 1970s. Our views, of course, are more aligned with the first book. The second book, however, raises important concerns about excessive regulation and how

We realize this debate will be resolved only with the benefit of hindsight, in the same way that realized productivity growth exceeded the prognostications of Hansen in the late 1930s and Krugman in the early 1990s.

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such regulation is "killing frontier innovation." Indeed, some have put forth the prevalence of poor government policies as one of the theories to explain the slow pace of this recovery.

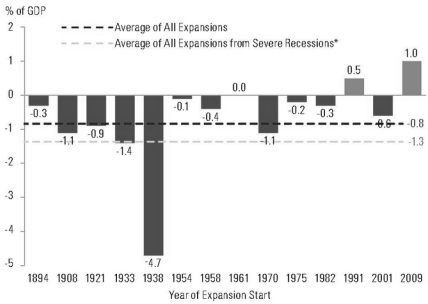
Poor Policies in Washington

One of the theories that has been getting more traction recently attributes the slower recovery to poor policies enacted in Washington. In a June 2016 article about the US economy, Gregory Mankiw, professor at Harvard University and former chair of the Council of Economic Advisers for President George W. Bush, highlighted "policy missteps,"[43] including misguided fiscal policy, as a possible contributor to the slow pace of growth since the global financial crisis.

One unusual feature of this recovery has, in fact, been a contractionary fiscal policy. We have derived an approximate historical measure of fiscal policy changes by estimating changes in the cyclically adjusted federal budget as a percentage of GDP. We note that, by this measure, as far back as 1890, fiscal policy has been expansionary in all but three recoveries following a recession—with the fiscal policy in the current recovery being the most contractionary, as shown in Exhibit 16. In this recovery, the budget deficit as a share of GDP was reduced by 1.0% a year, compared to an average widening of the budget deficit by 1.3% a year in all other recoveries after severe recessions. The average increase in the size of the budget deficit for all recoveries, including less severe ones, is -0.8%. A swing of 1.8 percentage points would have had a material impact on the pace of this recovery.

Exhibit 16: Change in US Budget Balance Following Recessions

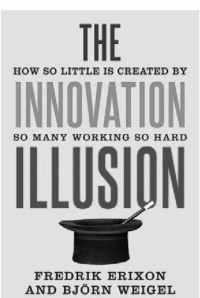
Fiscal policy has been an unusually large headwind to growth in this recovery.



Data through 2015.
Note: Shows the change in the cyclically adjusted budget balance as a % of GDP for each episode.
Source: Investment Strategy Group, Datastream, Global Financial Data.
* We define "severe" recessions according to those identified by Carmen Reinhart and Kenneth Rogoff in "Recovery from Financial Crises: Evidence from 100 Episodes" (2014), as well as the 1937 recession (a continuation of the 1929 recession) and the two most severe post-WWII recessions (excluding the 2007 recession).

Professor Alan Blinder of Princeton University and former vice chair at the Federal Reserve echoed the sentiment by stating that partisan politics have prevented progress in dealing with important economic issues.[44] Shambaugh has outlined various measures, such as infrastructure spending proposed by President Obama in his fiscal year 2017 budget, that would positively impact productivity and labor force participation.[45] The budget was not approved. Summers has similarly called for expansionary fiscal policy through infrastructure spending, but such policies have not been pursued.[46]

Increased regulation has also been blamed for some of the slow pace of this recovery. A September 2016 working paper by Martin Neil Baily and Nicholas Montalbano of the Brookings Institution on the slow growth of US productivity shows that while productivity in the most productive firms is growing rapidly, their best practices are not spreading to the rest of the players in a given industry.[47] Exhibit 17 shows the widening gap between the productivity growth rates of firms at the frontier of innovation and



Two books published in 2016 and written by Swedes born in the early 1970s highlight the conflicting perspectives on productivity.
Johan Norberg's *Progress* cover used with permission of Johan Norberg and Oneworld Publications. All rights reserved.
Fredrik Erixon and Bjorn Weigel's *The Innovation Illusion: How So Little Is Created by So Many Working So Hard* cover used with permission of Fredrik Erixon, Bjorn Weigel and Yale University Press. All rights reserved.

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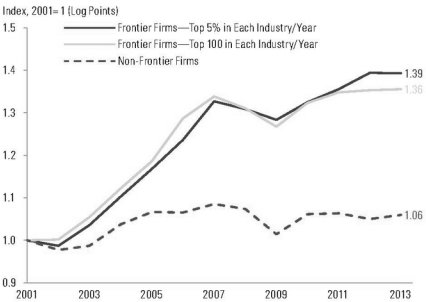
Exhibit 17: Labor Productivity Growth for Different Groups of Firms

Rapid productivity growth of firms at the frontier of innovation is not spreading to the rest of the industry.



Data through 2013.
Note: Average across 24 OECD countries and 22 manufacturing and 27 market services industries.
Source: Investment Strategy Group, OECD preliminary results based on Dan Andrews, Chiara Criscuolo and Peter N. Gal, "Mind the Gap: Productivity Divergence Between the Global Frontier and Laggard Firms," OECD Productivity Working Papers, forthcoming.

Exhibit 18: US Financial Conditions Index

Conditions tightened significantly due to global shocks emanating from the Eurozone, oil prices and China.

Data through year-end 2016.
Source: Investment Strategy Group, Goldman Sachs Global Investment Research.

the rest of the industry. Baily and Montalbano suggest that increased regulation after the crisis may be partially responsible for the widening gap between frontier firms and the rest of the industry, which lowers overall productivity growth rates across the economy and hence lowers the pace of economic growth.

Our colleagues in GIR think that lower capital investment accounts for the lack of diffusion of new technologies from more productive firms to less productive firms.[48] Here, again, it is likely that a more favorable business environment could have boosted capital expenditures and increased overall productivity levels.

We conclude that it is reasonable to assign some of the weakness in this recovery to less effective fiscal and regulatory policies out of Washington rather than to structural shortcomings in the US economy.

A Steady Onslaught of External Shocks

A sixth theory posits that numerous external shocks explain the slow pace of this recovery. Just as the US economy was recovering from the trough of 2009, the Eurozone sovereign debt crisis jolted global financial markets. The Eurozone was a source of uncertainty and financial market volatility beyond the initial shock in 2010 as the crisis spread from Greece to Spain and Italy.

The Eurozone crisis was followed by a series of what the Brookings Institution has called the "fiscal fights of the Obama administration."[49] The first fiscal fight resulted in the Standard and Poor's (S&P) downgrade of US Treasury debt in August 2011. The equity markets, as measured by the S&P 500 Index, dropped about 19% between April and October of 2011.

Taken together, the Eurozone sovereign debt crisis and the first of the fiscal fights tightened US financial conditions[50] by 142 basis points (see Exhibit 18). GIR estimates that a 100 basis point tightening of financial conditions is equivalent to a federal funds hike of 150 basis points and a drag on GDP growth of about one percentage point.

The drop in oil prices from a post-crisis high of $107 per barrel for West Texas Intermediate in June 2014 to a trough of $26 per barrel in February 2016 also provided a shock to the economy. Employment and capital expenditures in the oil and gas sector dropped by 29% and 67%, respectively, from peak levels seen in 2014. The sector's par-weighted default rate excluding distressed exchanges reached 14.6% and including such exchanges 19.8%, in October 2016.[51]

Broad-based fear of policy mistakes in China and unexpected depreciation of the renminbi were

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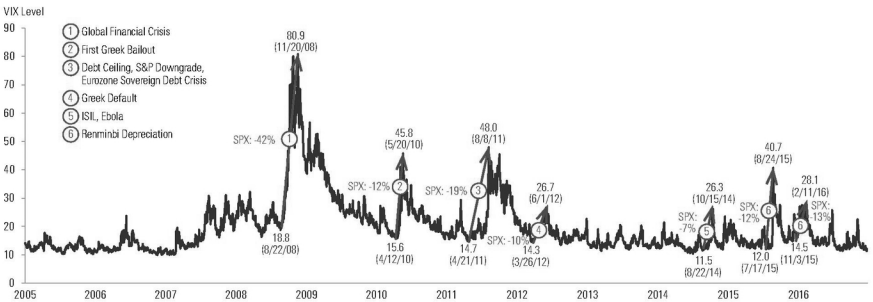
Exhibit 19: US Equity Volatility

Spikes in equity volatility have corresponded with major global shocks.



Data through December 31, 2016.
Note: The red arrows show the S&P 500's (SPX's) peak-to-trough declines around each episode.
Source: Investment Strategy Group, Bloomberg.

another shock to the financial markets, resulting in the tightening of financial conditions in the US in mid-2015 and early 2016, with US equities dropping by more than 10% in both periods.

Exhibit 19 provides a time line of shocks, which, in all likelihood, dampened the pace of the US recovery.

In Summary

As we review the six theories that could account for the notably slow pace of this recovery, we believe that all have some merit. Recovering from the hangover from the deepest recession since the Great Depression took a little longer. Demographics have not been favorable. Productivity growth appears lower, but that fact does not portend weak productivity growth in the future. Productivity growth is also probably not as weak as it appears, given some mismeasurement of GDP. Fiscal and regulatory policies hampered the economic recovery. And the global backdrop provided a steady source of shocks that slowed growth in the US.

That said, we feel confident that the US continues to progress on a solid footing, that the recovery is intact and, as we argued in our 2016 *Outlook: The Last Innings*, that this recovery and bull market have another inning or two left to run. The glass is still half-full.

We now turn to our expected returns for the next one and five years.

One- and Five-Year Expected Total Returns

The Investment Strategy Group began producing one- and five-year annualized expected total returns for major asset classes in our 2013 *Outlook*. Since then, our key message has been to stay invested in US equities despite the low returns we have expected for the asset class. Our recommendation has been driven by a low probability of recession, a reasonable probability of upside for equities, zero expected returns for cash and negative expected returns for bonds.

We have presented these one- and five-year annualized expected returns to: a) provide more context for our investment recommendations; b) encourage our clients to have a longer investment horizon; and c) increase the odds that our clients have greater staying power to withstand market downdrafts.

Fulfilling these three priorities is even more imperative moving forward. Our return expectations are lower than in prior years after several years of outsized returns in equities and high yield, and, at the same time, we are confronted with tremendous economic policy and geopolitical uncertainty. We have been faced with such uncertainty in the past, but today (in contrast with periods such as 2008), we no longer have the wind at our back with the benefit of cheap equity and high yield valuations. In 2008, we believed that attractive valuations would eventually lead to high prospective returns in US equities and high

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yield, notwithstanding short-term uncertainty. At the dawn of 2017, we face uncertainty, but US equities and high yield are expensive, and valuations no longer provide much margin of safety and protection from the downside. Similarly, other asset classes such as fixed income provide negligible returns but come with downside risk, e.g., if the incoming Trump administration's fiscal policy is more stimulative than we expect or if the Federal Reserve raises interest rates at a more rapid pace than we expect.

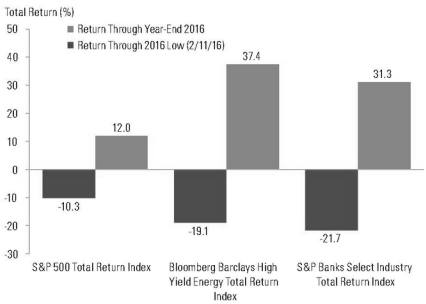
As we prepared our one- and five-year annualized expected returns for this *Outlook* and finalized our investment recommendations for 2017, we were struck by two observations.

First, the general recommendations and volatility warnings in our *Outlook* publications over the last several years have been similar, have been directionally correct and have generally added value to our clients' portfolios. We have continuously recommended that clients stay invested in their strategic US equity allocation. We have also recommended maintaining some tactical tilts such as an allocation to high yield. Yet we have warned clients to be prepared for bouts of volatility. Last year, our exact message to clients with respect to volatility was that "markets will be volatile, so an asset class that performs well in the first half of the year may perform particularly poorly in the latter part of the year; however, investors—unlike traders—should not try to time such short-term moves."[52] It is very important that clients heed this warning—not just for 2017 but for their entire investing lives.

Exhibit 20 illustrates the point. We have compared the performance of some of the best-performing asset classes and sectors for the year with the performance of those assets at their worst point of the year. Energy high yield provides an excellent example. On February 11, 2016, the US energy high yield sector (as measured by the Bloomberg Barclays High Yield Energy Total Return Index) was down 19.1% year to date—one of the worst-performing sub-asset classes at that time. Similarly, the US bank sector (as measured by the S&P Banks Select Industry Total Return Index) was down 21.7% over the same period. We had in place tactical tilts in both sectors. As oil prices recovered, high yield energy securities rallied, with the benchmark index ending the year up 37.4%—a wild swing of 56 percentage points from low to high. US banks also rallied initially in response to prospects of higher interest rates and later in anticipation of less regulation under a Trump administration. The bank sector index rallied to end the year 31.3% higher than at the start—an equally wild swing of 53 percentage points from low to high.

Exhibit 20: Returns in 2016

Some of the best-performing assets in 2016 experienced significant declines before recovering.



Data through December 31, 2016.
Source: Investment Strategy Group, Bloomberg.

The general recommendations and volatility warnings in our *Outlook* publications over the last several years have been similar, have been directionally correct and have generally added value to our clients' portfolios.

We have to be realistic: we cannot anticipate such market swings on a consistent basis. Therefore, it is imperative that clients maintain a long investment horizon, be tactical when investment opportunities present themselves—usually at times of extreme stress in the financial markets—and otherwise stay invested in the appropriate strategic asset allocation.

Our second observation was that our five-year annualized return forecasts

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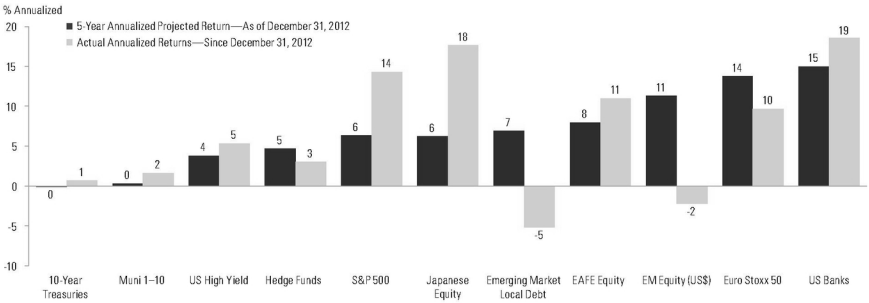
Exhibit 21: Historical Total Returns vs. ISG's 2013 *Outlook* 5-Year Prospective Total Returns

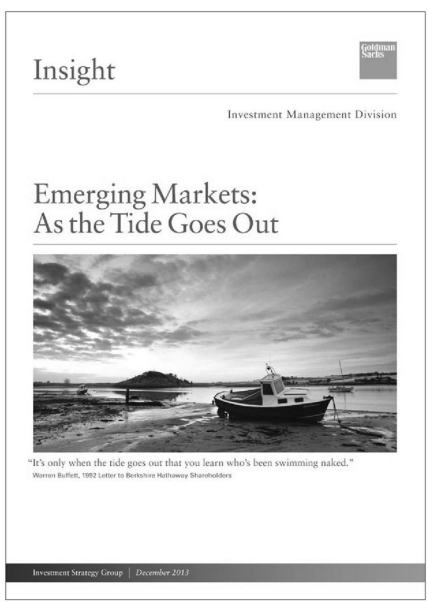
Our 5-year return forecasts have so far been relatively accurate for the bulk of assets in our diversified model portfolio, but we have not been right across the board.



Data through December 31, 2016.
Note: Rounded to the nearest whole integer.
Source: Investment Strategy Group, Datastream.

have also been relatively accurate for the bulk of assets in our diversified model portfolio. In Exhibit 21, we compare the five-year annualized expected total returns published in our 2013 *Outlook* to what transpired over the last four years. Our forecasts for 1) fixed income returns including both investment grade and high yield, 2) hedge fund returns, and 3) EAFE equity returns were close to the mark. Directionally, we were also right about US equity returns but off in terms of magnitude. We were also struck by how close our US bank sector return forecasts were to the realized returns—approximately a quarter of which were realized after the November election. This observation has reinforced our belief in one of the pillars of our investment philosophy: having the appropriate horizon for various strategies is critical to long-term success.

Not surprisingly, we have not been right across the board. We underestimated Japanese equity returns by 11.4 percentage points on an annualized basis and we overestimated emerging market equity and emerging market local debt returns, by sizable 13.5 and 12.1 percentage points, respectively, on an annualized basis. Japanese equities realized an annualized 18% return and EM equity and local debt realized negative returns, at -2% and -5% annualized, respectively. While our forecasts were off the mark, our emerging market investment recommendations were on the mark. In mid-2013, we recommended clients reduce their strategic allocation to emerging market assets. Even though we had forecast expected returns that were nearly double those of US equities, we became


Insight

Goldman Sachs

Investment Management Division

Emerging Markets: As the Tide Goes Out

"It's only when the tide goes out that you learn who's been swimming naked."
Warren Buffett, 1992 Letter to Berkshire Hathaway Shareholders

Investment Strategy Group | *December 2013*

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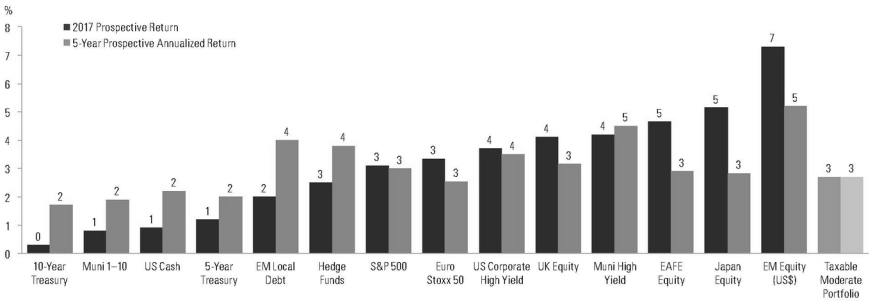
Exhibit 22: ISG Prospective Total Returns

Expected returns over the next one and five years are below historical realized averages.



Data as of December 31, 2016.
Note: For informational purposes only. There can be no assurance the forecasts will be achieved.
Source: Investment Strategy Group. See endnote 53 for list of indices used.

increasingly concerned about the structural fault lines of emerging market countries. These fault lines were discussed in detail in our December 2013 *Insight*, *Emerging Markets: As the Tide Goes Out*.

We continue to recommend a zero allocation to emerging market debt (dollar-denominated and local currency debt) and a 2% allocation to emerging market equities in a moderate-risk diversified portfolio. We highlight emerging market assets because, yet again, our base case returns, especially for emerging market equities, appear compelling, but we are not recommending a tactical allocation to this asset class. As we discuss below in our review of the risks to our economic and financial market outlook, China is our biggest source of concern in 2017 and for the next few years. Emerging markets are the countries that would be most negatively impacted by any shocks emanating from China.

China is our biggest source of concern in 2017 and for the next few years. Emerging markets are the countries that would be most negatively impacted by any shocks emanating from China.

Our 2017 expected returns, shown in Exhibit 22, are the lowest returns we have published since the global financial crisis. Not a single broad asset class is expected to have double-digit returns. Cash has an expected return of 1%. Expected returns for intermediate investment grade fixed income securities range between 0% and 1% depending on maturities, an expectation driven by our view of rising rates as the Federal Reserve hikes the federal funds rate two or three times in 2017. US equities, which are the most expensive of global equities, have an expected return of about 3%, and we expect slightly higher returns in other developed market equities. Hedge funds, an asset class for which we have had modest single-digit return expectations since our 2013 *Outlook* (as shown in Exhibit 21), should continue to have modest returns; we expect a 3% return before taxes, compared to a 5% annualized return expectation in 2013 and an annualized return of 3% over the last four years.

In aggregate, a moderate-risk diversified portfolio for taxable clients is expected to have a return of about 3%. We must note that our return expectations are not meant to promote a specific investment, and that their basis on current capital market assumptions implies they will likely change over the course of the year.

At this point, our clients may well be asking why they should remain invested in a diversified portfolio with such paltry

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return expectations, given all the economic policy and geopolitical uncertainty mentioned earlier. We believe there are three compelling arguments.

First, there is potential for upside surprises in 2017:

- Saudi Arabia and the rest of the oil producers may stick to the announced oil production cuts, thereby boosting energy sector earnings.
- A Trump administration fiscal stimulus could boost growth by more than we expect.
- Corporate tax cuts could increase corporate sector profitability.
- A possible tax holiday could encourage US multinational corporations to repatriate some of their earnings and deploy them for stock buybacks.

We assign a 25% probability of such upside surprises relative to a 60% probability of our base case scenario and a 15% downside probability. (Please see Section III, 2017 Financial Markets Outlook, for a more detailed discussion.)

Second, we recommend staying invested because we believe that the probability of a recession in the US is about 15% over the next year. There is an 85% chance that the economy will grow at a rate of about 2% or higher. Absent a recession, equities are more likely to generate positive returns. Obviously, the probability of a recession is substantially higher over the next five years, and our five-year annualized expected returns incorporate a 70–80% probability of a recession.

Third, and most importantly, we do not see better investment alternatives. Cash will provide negligible returns with no upside, and we expect investment grade bonds to have equally negligible returns with little upside, if any. We also expect hedge funds, in aggregate, to lag equities on an after-tax basis.

We expect similarly modest returns from our tactical tilts.

As equities, high yield and the dollar have rallied over the course of the year, we have continued to reduce the overall risk level of our tactical tilts.

Our Tactical Tilts

As equities, high yield and the dollar have rallied over the course of the year, we have continued to reduce the overall risk level of our tactical tilts. At the beginning of 2016, we had already reduced our exposures by 50% relative to peak levels in 2015, as measured by value at risk. By the end of 2016, we had reduced exposures further, based on our investment discipline of averaging in and out of our tactical tilts.

Underweight Fixed Income: We continue to recommend underweighting US fixed income assets as the Federal Reserve slowly but steadily raises the federal funds rate. We expect the 10-year Treasury bond yield to range between 2.5% and 3.0%. As a result, we forecast a 1% return across short- and intermediate-maturity fixed income assets and a near zero return for the 10-year Treasury. Longer maturities are expected to have negative returns. We also recommend underweighting fixed income assets to fund tactical tilts given their higher expected returns.

Overweight to High Yield: While we reduced our tactical allocation to high yield assets by half throughout 2016, we continue to recommend an allocation to general high yield bonds, high yield energy bonds and high yield bank loans. The incremental yield in such securities, adjusted for defaults, is still compelling, with expected returns of about 4% for high yield bonds and high yield energy bonds and about 5% for bank loans. We forecast that crude oil prices will stay in the $45–65 range, partly owing to some production discipline by Saudi Arabia as the largest swing producer. Our bank loan tilt is further supported by a rising rate environment; the coupon rate on bank loans will be reset higher as LIBOR rises.[54]

Modest Overweight to US Banks: We maintain a modest overweight to US banks despite their 31% return in 2016. Banks will benefit from rising rates, especially if the increase is greater in the short end of the yield curve. About 60% of changes in the net interest margin of banks is typically driven by changes in short rates since they are used for setting the banks' prime lending rate. Banks will also likely benefit from a more favorable regulatory environment under a Trump administration. We forecast a return of about 7%.

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Overweight US Energy Infrastructure Master Limited Partnerships (MLPs): We initiated a direct allocation to energy MLPs in late January 2016 and have maintained that tilt. Given our assumptions about oil prices, we believe that the cash distributions from MLPs are generally secure and provide a yield to investors of just over 7%. In the absence of any valuation changes, the yield translates into a high single-digit tax-advantaged return. Any growth in cash flow distribution or improvements in valuation relative to the S&P 500 would provide some upside.

Overweight Spanish Equities: We maintain an overweight to Spanish equities on a currency-hedged basis. This tactical tilt was introduced in August 2013, and we have adjusted the size of the overweight about a dozen times since. Spanish equities offer some of the cheapest valuations across the developed markets, attractive dividend yields, expected earnings growth of 4.6%, aided by healthy domestic growth, and a particularly well-capitalized[55] banking sector that has a lower nonperforming loan ratio than the Eurozone bank average. Furthermore, Spain is unlikely to face the same political uncertainty as Germany, France and Italy in 2017. We expect high single-digit returns for Spanish equities.

Short Five-Year German Bunds: We recommend a short position in five-year German bunds as the ECB embarks upon the process of shifting its monetary policy. After the December 2016 meeting, the ECB announced that it would reduce its monthly purchases of bonds from €80 billion to €60 billion starting in March 2017 and continuing through December 2017. We expect the ECB to end all purchases sometime in 2018, barring any shocks. As a result, we think interest rates for Eurozone sovereign debt will rise gradually over the course of the year, which in the case of German bunds means they will become less negative. We expect a modest 2% return from this tilt.

Short Chinese Renminbi: We have increased our bearish position on the Chinese renminbi over the course of 2016. China is under pressure from multiple sides: the need for loose monetary policy to achieve the leadership's 6.5% target GDP growth rate, 32 months of capital outflows that have accelerated in late 2016, a strong dollar and an incoming Trump administration that will likely pursue a US-centric policy toward China. Risks are exacerbated by the leadership's lack of experience in handling financial market volatility, as evidenced by China's policy response to its equity market collapse in June 2015 and its approach to shifting the currency regime to a more flexible one in August 2015 and January 2016. We expect the currency to depreciate about 7% in 2017; since 4% is already priced in the forward markets, we expect a return of about 3%. There is considerable scope for further upside from this tilt if China abandons its current control of the currency, a move that could lead to depreciation in the renminbi of about 20%.

Our tactical tilts are based on above-trend growth of 2.3% in the US, global growth of 2.9%, generally favorable monetary policy and more stimulative fiscal policy across developed and emerging market countries. We expect returns to be muted across asset classes, resulting in modest returns in a diversified portfolio with a modest enhancement from tactical tilts. Of course, our views are not without risks. As we discuss below, some are low-probability risks with the potential for high impact while others are high-probability risks with low impact potential.

The Risks to Our Outlook

When we think about the risks to our economic and financial market outlook, we are reminded of the words of French writer Jean-Baptiste Alphonse Karr: *Plus ça change, plus c'est la même chose*—the more things change, the more they stay the same. This year's list of risks overlaps with those of the last several years. As far back as 2011, investors have worried about a hard landing in China. From the inception of the European sovereign debt crisis in 2010 through the Brexit vote in 2016, the potential breakup of the Eurozone has been a source of concern. As soon as the Federal Reserve raised the federal funds rate in December 2015, investors worried about tightening policy causing a recession. Cybersecurity and terrorism are constant threats. And geopolitical risks have grown over time. This year, we are adding trade policy uncertainty and US-China geopolitical relations as new risks.

As we said in our 2013 *Outlook*, there is no shortage of concerns as markets climb a wall of worry. In our view, there are eight risks that

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We do not believe this tightening cycle will lead to a US recession in 2017.

could derail the last innings of this recovery and bull market. The first three are low-probability risks in our view, the next three risks have a high probability of occurring but their impact is uncertain and the last two are high-probability and high-impact risks beginning as early as 2017.

Low-Probability but High-Impact Risks:

- The pace of Federal Reserve tightening is disruptive and financial markets react negatively.
- The economy slips into recession.
- Populist parties in the Eurozone gain greater influence.

High-Probability but Uncertain-Impact Risks:

- Geopolitical hot spots get hotter.
- Terrorism escalates.
- Cyberattacks continue.

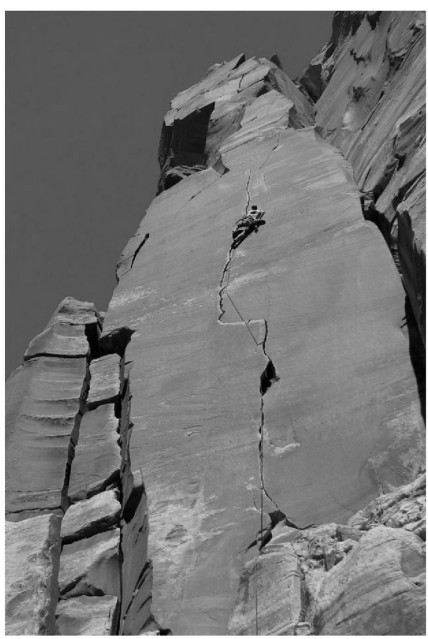
High-Probability and High-Impact Risks:

- China submerges under its debt burden and capital outflows.
- US-China relations deteriorate under the Trump administration.

Pace of Federal Reserve Tightening

Unlike the December 2015 interest rate hike that prompted a vocal response from naysayers but had limited impact on the bond market, the December 2016 hike has elicited a muted response from market commentators but has had a larger impact on the bond market. The underlying strength of the labor market and the steady improvement in the economy have led to a change of sentiment toward more interest rate hikes, which are clearly in the offing. Interest rates have increased from a low of 1.3% for the 10-year Treasury in July 2016 to 2.4% by year-end. While this increase in interest rates would ordinarily tighten financial conditions, it has been partially offset by stronger equity markets and tighter corporate bond spreads. In fact, financial conditions were looser at the end of the year than they were at the beginning of 2016 despite expectations of a slow but steady increase in the federal funds rate.

We share the market view that the pace of monetary policy tightening will accelerate but remain benign. As shown in Exhibit 23, the difference between the Federal Reserve dots, the view implied by the bond market, the forecast by our colleagues in GIR and our view is negligible. The bond market has priced two hikes, the Federal Reserve and GIR expect three hikes, and we think two or three hikes are equally likely in 2017. We assume that the Federal Reserve will slow down the pace of interest



There is no shortage of concerns as markets climb a wall of worry.

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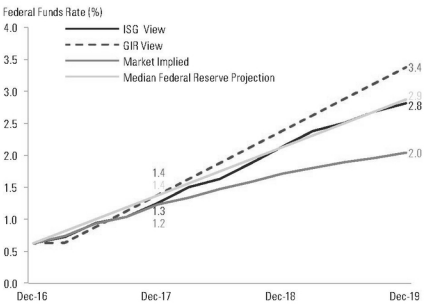
Exhibit 23: Policy Rate Path Projections

We expect the pace of monetary policy tightening to accelerate but remain benign.



Data as of December 31, 2016.
Note: For informational purposes only. There can be no assurance that the forecasts will be achieved.
Source: Investment Strategy Group, Bloomberg, Goldman Sachs Global Investment Research, Federal Reserve.

rate hikes should the economy weaken, and will pick up the pace later in 2017 or 2018 if the fiscal package under the Trump administration is bigger than we expect (see Section II, 2017 Global Economic Outlook, for a more detailed discussion).

Irrespective of the realized pace, this tightening cycle will not result in a US recession in 2017, in our view.

Recession Is Highly Unlikely

"Depression Bread Line," Bronze, 1991, George Segal at the Franklin D. Roosevelt Memorial. Art © The George and Helen Segal Foundation/Licensed by VAGA, New York, NY.

Low Expectations of a US Recession

Recessions in the US have been triggered by Federal Reserve tightening of monetary policy; by economic imbalances such as the bursting of the dot-com and housing bubbles in 2000 and 2008, respectively; or by external shocks such as the Arab oil embargo in 1973. The first two triggers are unlikely to occur in 2017, and the third, a shock, is not something that we can typically anticipate. However, we do think that China will be a source of downside risk sometime over the next three years.

First, as we mentioned in last year's *Outlook*, there have been five tightening cycles in the post-WWII period that have not triggered a recession. Four of those cycles occurred during the three longest recoveries, as shown in Exhibit 24. Those cycles have been characterized by an early start to the tightening cycle, a slow pace relative to historical averages (220 basis points per year for nonrecessionary tightening and 330 basis points per year in recessionary cycles), low core inflation and slack in the labor market. This cycle shares those characteristics: the tightening cycle started in 2015, the pace has been 25 basis points per year, the core personal consumption expenditures (PCE) index—the Federal Reserve's preferred benchmark for inflation—is at 1.6% year over year as of November 2016, and our colleagues in GIR estimate that the labor market still has about 0.3% slack.

Second, the US economy does not suffer from any imbalances in which one sector of the economy has become the sole driver of growth or equity market returns. Before the global financial crisis, residential investment as a percentage of GDP had peaked at 6.7% in 2005, compared to a long-term average of 4.7%, and the credit-to-GDP gap as a measure of nonfinancial sector leverage had peaked at 12.4% in 2007 compared to a long-term average of -1%, leading to meaningful imbalances. Similarly, in 2000, technology and telecommunication sector valuations were more than three standard deviations higher than the average of other sectors. Such imbalances do not exist in the US at this time.

Third, while we cannot anticipate an external shock—otherwise it would not be a shock—we do not see imbalances in other large economies except in China.

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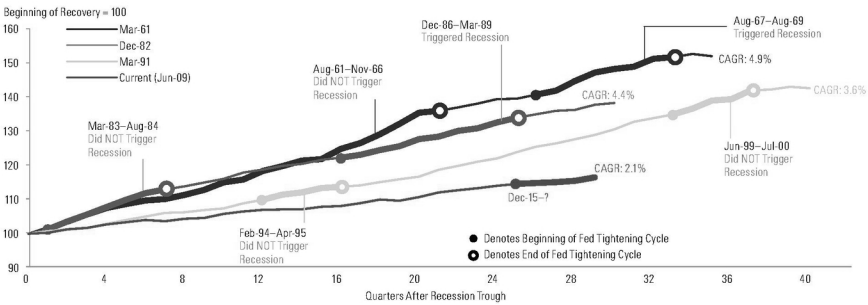
Exhibit 24: US Real GDP During the Longest Post-WWII Recoveries

Four of the five tightening cycles that did not trigger a recession occurred during the three longest recoveries in the post-WWII period.



Data as of December 2016.
Source: Investment Strategy Group, Bloomberg, National Bureau of Economic Research.

In our 2016 *Outlook* and our 2016 *Insight* report, *Walled In: China's Great Dilemma*, we stated that China was unlikely to have a hard landing over the next two years (i.e., 2016 and 2017). We believe the view still holds. We do not expect a hard landing in China that would destabilize the US economy in 2017, but the risks grow significantly in 2018 and 2019. As we discuss below, China may nevertheless represent a geopolitical risk in 2017.

Historically, since WWII, the odds of a recession occurring over a 12-month period have been 18%. Our composite recession model, incorporating end-of-year financial and economic data, estimates the probability of a recession in 2017 at 23%. Once we incorporate the likely passage of a fiscal stimulus package of tax cuts and infrastructure investments in the latter half of 2017, the probability of a recession this year declines to about 15%.

Rising Influence of Populist Parties in the Eurozone

Since the election of Prime Minister Alexis Tsipras and the Syriza Party in Greece in January 2015, populism has been gaining momentum across Europe. The support for populist parties has increased to varying degrees in Spain, Greece, Italy, France, the Netherlands, Germany and Austria. The common themes among populists have been anti-immigration and anti-European Union. Outside the Eurozone, the 2016 Brexit vote in Great Britain has been interpreted as a populist vote against immigration from Eastern Europe, the Middle East and North Africa, as well as against the bureaucracy of the European Union.

The increasing enthusiasm for populist parties in Europe raises two questions. First, will any of the more extremist parties win enough support to break away from the European Union? In France, for example, upcoming elections in May 2017 are likely to pit François Fillon of Les Républicains against Marine Le Pen of the far right Front National. Le Pen has promised a referendum on whether France should stay in the European Union, and, should she win, questions about the viability of the Eurozone will surface immediately.[56] While polls show Fillon well ahead of Le Pen, polls have been wrong on the UK and Italian referenda and the US election. The Eurasia Group, for one, assigns a 30% probability to a Le Pen victory.[57]

Second, to what extent will the rise of populism influence policies in the Eurozone? Here, Germany will probably provide a litmus test. Chancellor Angela Merkel and her coalition government are likely to respond to recent terrorist attacks there by proposing a stronger police and military presence, according to the Eurasia Group. Security checks will probably be increased as well, since at least 800,000 asylum-seekers entered Germany with minimal security checks and terrorist suspects have already been arrested among them.[58] With German elections scheduled for September 2017, it remains to be seen whether Chancellor Merkel will adjust her immigration policy.

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While populism is on the rise and the support for such parties has increased, we do not think that these movements will threaten the viability of the Eurozone in 2017. In fact, in response to Brexit, we believe that Eurozone policymakers will take a hard line with Britain to make sure other countries do not think it realistic to manage an exit that retains all the benefits while shouldering none of the costs.

Geopolitical Hot Spots Get Hotter

We rely on the insights of external experts to formulate our geopolitical views. They include members of prominent research groups, think tanks and universities as well as former government officials, both in the US and abroad. So informed, we highlight activity in North Korea, Russia and the Middle East among our group of risks with high probability but uncertain impact.

North Korean Belligerence Continues: North Korea's unpredictable and belligerent military activities have continued unabated. In early 2016, North Korea announced that it had tested its first hydrogen bomb.[59] By the end of 2016, North Korea had conducted nine other military actions, including the launch of a ballistic missile from a submarine,[60] launches of long-range ballistic missiles toward Japan[61] and additional nuclear tests.[62]

We can only expect further tests in 2017, given the estimates by a Council on Foreign Relations task force chaired by retired Admiral Michael Mullen that North Korea may have between 13 and 21 nuclear weapons as of June 2016.[63]

Even more troubling is a pattern highlighted by David Gordon, adjunct senior fellow at the Center for a New American Security. Gordon points out that North Korea makes a habit of testing new presidents, as it did in May 2009, early in President Obama's first term, and again in February 2013 after South Korean President Park Geun-hye was inaugurated.[64]

The *Wall Street Journal* reports that the "Obama administration considers North Korea to be the top national security priority for the incoming administration."[65] Nuclear weapons already in place, long-range ballistic missile capabilities in development, and an unpredictable and provocative leader are a deadly combination. North Korea will remain a serious risk for the foreseeable future.

Russian Adventurism Intensifies: While attention has been focused on Russia's adventurism in Syria, the frozen conflict in Ukraine remains intact, with increasing violations of the Minsk agreements of 2014 and 2015.[66] Since the first agreement in September 2014, nearly 10,000 people have been killed,[67] and most recently, Russian-backed separatists attempted to break through Ukrainian government lines.[68] In response to such lack of progress and concerns about further Russian aggression in the region, the heads of North Atlantic Treaty Organization (NATO) member countries agreed, at a summit in Warsaw in July 2016, to deploy as many as 4,000 troops to the Baltic States and Poland in early 2017 as a deterrent to further adventurism in Eastern Europe.[69] The risks of accidents and intentional skirmishes will inevitably rise.

Furthermore, the direction of foreign policy in the region under a Trump administration is uncertain given President-elect Trump's July 2016 statement that the US would not automatically defend the Baltic States.[70]

Russia is likely to stay involved in the Middle East as well. Russia has been a constructive force with respect to the fight against the Islamic State of Iraq and the Levant (ISIL) and a stabilizing force with respect to keeping Syrian President Bashar al-Assad in place in the absence of any attractive alternatives. Syria would not have made as much progress in pushing back ISIL and the rebels without Russian air power support. Russia has also hosted a meeting in Moscow with Iran and Turkey to work toward an accord to end the war in Syria[71]—a six-year war that has resulted in 400,000[72] to 470,000 fatalities[73] and an estimated economic cost of $250 billion to $275 billion.[74] Given the prospects of continued geopolitical turmoil in the region, Russian involvement in the Middle East will not be reduced anytime soon.

While populism is on the rise and the support for such parties has increased, we do not think that these movements will threaten the viability of the Eurozone in 2017.

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Middle East Conflicts and Tensions Persist: The Middle East will remain a source of conflict for years to come. Many countries have weak or collapsing nation-state structures with varying degrees of civil war. As Zalmay Khalilzad, former ambassador to Afghanistan, Iraq and the United Nations, and president of Gryphon Partners, wrote recently, "the national borders devised by Western powers for Iraq and Syria, in particular, are not standing up well to the test of time … and Pakistan's policies have contributed to Afghanistan's precarious condition."[75] Iran and Saudi Arabia compete for influence in the region, and the Sunni-Shia divide that was not a geopolitical factor 40 years ago will continue to escalate tensions in the region.

Another potential risk in the region is the dismantling of the Iran nuclear deal by the Trump administration.[76] In the absence of a deal, Iran would return to building its nuclear capabilities, thereby increasing the risks of a military strike by Israel or the US.

We assign a low probability to such an event for two reasons. First, we point to comments made by secretary of defense nominee retired General James Mattis, which suggest a different approach in dealing with Iran.[77] In a speech in April 2016 at the Center for Strategic and International Studies, Mattis said "there is no going back" on the deal "absent a clear and present violation."[78] Second, other signatories to the deal, including Russia and China, would not support a unilateral dismantling of the deal by the new administration.[79] That is not to say that tensions between the US and Iran will not continue this year.

Turmoil in the region will continue into 2017 and beyond. While the direct impact of such conflicts on global growth and world equity markets is limited outside a war among major powers, the threat posed by terrorism is significant and growing.

Terrorism Escalates

Another high-probability but uncertain-impact risk is increased terrorism. The Middle East has been the main source of terrorism even before the September 11, 2001, attack on the World Trade Center. The majority of the 9/11 perpetrators, 15 out of 19, were from Saudi Arabia, with the rest from other Arab countries in the region.[80] Since then, the spread of ISIL, the Syrian civil war, extremism in Pakistan and Afghanistan, and the immigration of Arabs and North Africans to Europe and, to a lesser extent, the US, have increased the incidence of terrorism in the West.

In 2016, there were five key terrorist incidents in the US and 15 in Europe, including a December 19 attack when a truck rammed into a Christmas market in Berlin.[81] Some of the terrorists responsible were inspired by ISIL,[82] and some were lone-wolf Islamic extremists who had lived in their respective countries for years.[83] With a growing number of refugees in Europe, it is highly likely that this pace of terrorism will continue.

Terrorist attacks and geopolitical tensions in the Middle East take more than their immediate human toll. While consumer confidence in the US is now above the pre-global financial crisis peak of July 2007 (see Exhibit 25), Gallup Poll data shows that dissatisfaction remains at a very high level, similar to that at the beginning of the global financial crisis. As shown in Exhibit 26, the dissatisfaction rate increased steadily in the aftermath of the 9/11 terrorist attacks and the US wars in Afghanistan and Iraq. It had already reached current levels before the global financial crisis.

Former Federal Reserve Chairman Ben Bernanke has named traumatic national shocks such as 9/11 along with political polarization and "shrill" political debates as possible culprits of the contradictory signals between the high levels of consumer confidence as measured by the Conference Board and the high levels of dissatisfaction as measured by Gallup Polls.[84]

Risks of continued terrorism are very high, but the broader economic impact of the type of terrorist acts we witnessed in 2016 is limited. We can only hope that large attacks such as 9/11 do not occur again.

Cyberattacks Continue

High-profile cyberattacks or cyberattack announcements were a regular feature of 2016. The highest-profile attacks were those perpetrated by the Russian government on the Democratic National Committee computer network, according to a joint statement from the Department of Homeland Security and Office of the Director of National Intelligence on Election Security.[85] The US government expelled 35 Russian officials and imposed sanctions on four high-ranking members of the Russian military intelligence unit as a result.[86]

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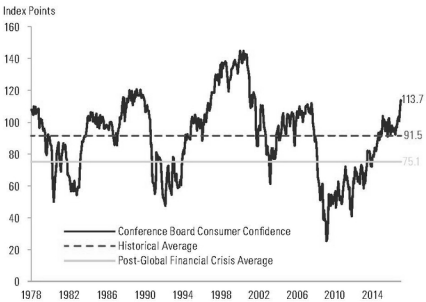
Exhibit 25: Conference Board Consumer Confidence Index

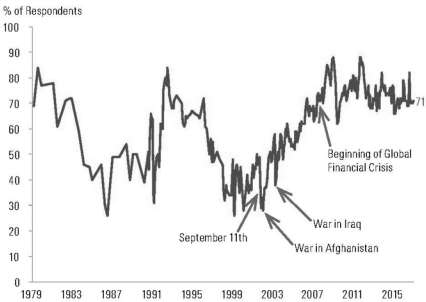
The labor market recovery has led to a steady increase in consumer confidence.



Data through December 2016.
Note: Series starts in January 1978. Post-GFC average begins in July 2009.
Source: Investment Strategy Group, Datastream.

Exhibit 26: Gallup Poll on Satisfaction With the Direction of the US

Dissatisfaction remains at a very high level, similar to that at the beginning of the global financial crisis.



Data through December 2016.
Note: The poll asks, "In general, are you satisfied or dissatisfied with the way things are going in the United States at this time?"
Source: Investment Strategy Group, Gallup.

Other high-profile cyberattacks included

- The announced theft of the account information of 1 billion Yahoo users in 2013 and 500 million Yahoo users in 2014[87]
- The theft of information from as many as 700,000 accounts at the Internal Revenue Service[88]
- A suspected Chinese military hack into the Federal Deposit Insurance Corporation[89]
- The theft of 117 million LinkedIn passwords (stolen in 2012 but announced in 2016)[90]

The risks of cyberattacks continue to increase.

The risks of cyberattacks continue to increase. To date, the attacks have had limited detrimental impact on the broad US economy, but the impact could be far-reaching if foreign governments such as Russia or China, criminal entities, or lone actors attack critical infrastructure in the US or any other major country.

China Submerges Under Its Debt Burden and Capital Outflows

At $11.4 trillion, China is the second-largest economy in the world, with a 13.8% share of global exports and a 9.7% share of global imports. It accounts for nearly half of global demand for zinc, tin, steel, copper and nickel, and more than half for thermal coal, aluminum and iron ore. Any major slowdown or volatility across bond, currency and equity markets in China, including Hong Kong, would have major ramifications for the rest of the world.

While the US has limited direct economic exposure to China—only 0.6% of exports as a share of GDP, 0.6% of bank assets and 0.7% of corporate profits—any shocks in China will reverberate through US financial markets. As shown earlier in Exhibit 18 on page 19, US financial conditions tightened by 118 basis points in the summer of 2015

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when China's leadership intervened in the local equity markets and adjusted the trading band around the renminbi, and by 104 basis points in late 2015 and early 2016 when the leadership changed the reference currency from the dollar to a basket of 13 currencies. If US financial conditions had stayed at those levels for over a year, US GDP growth would have slowed by about one percentage point, all else being equal. Financial conditions are the mechanism by which shocks from China would have the most immediate impact on key developed economies such as the US.

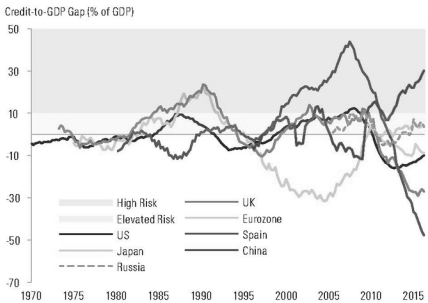
As mentioned above, one of the triggers of US recessions has been economic imbalances. While we do not see such imbalances in the US, or in other major developed economies, at this time, we see significant imbalances in China. Such imbalances have led to crises in other countries, and there is no reason to believe that they will not lead to a financial crisis in China. In our view, it is not a question of if—it is only a question of when.

The biggest imbalance in China is the high level of debt relative to GDP. The Bank for International Settlements (BIS) has a series of early warning indicators. One of the more widely followed and reliable measures is the credit-to-GDP gap, measured as the total credit extended to the private nonfinancial sector as a percentage of GDP compared with its long-term trend. As shown in Exhibit 27, China breached the high-risk threshold in June 2012, when its credit-to-GDP gap rose above the 10% level. At 30.1% as of March 2016 (latest data available) and rising, China's gap exceeds the 10% threshold by 20 percentage points, levels previously seen in Spain before the European sovereign debt crisis. Major developed and emerging market countries have experienced a financial crisis within three years of their credit-to-GDP gap exceeding 10%.

In our 2016 *Outlook* and our 2016 *Insight* report, *Walled In: China's Great Dilemma*, we stated that we did not expect a hard landing in China over the next two years—2016 and 2017. We continue to assign a low probability to a hard landing in China in 2017. However, it is unlikely that China can avoid a financial crisis over the next three years. In prior years, we have pointed to China's high savings rate and government control of many aspects of the economy as reasons for its ability to avert a hard landing. However, the country's debt levels have risen rapidly, the pace of capital outflows has picked up, and net foreign direct investment has reversed and is now negative. In our view, neither China's high savings rate nor its increasing government control of financial markets and capital flows will be sufficient to avert a hard landing over the next several years. Keep in mind that even the US was not able to avert a financial crisis after its credit-to-GDP gap briefly breached the 10% high-risk threshold in December 2006 and peaked at 12.4% in December 2007.

Exhibit 27: Credit-to-GDP Gap Across Economies

China's gap reached the high-risk threshold in June 2012 and has continued to rise.



Data through Q1 2016.
Note: Estimates based on series of total credit to the private nonfinancial sector. Credit-to-GDP gap is defined as the difference between the credit-to-GDP ratio and its long-term trend in percentage points. Long-term trend is calculated using an HP filter.
Source: Investment Strategy Group, Bank for International Settlements.

The US has the highest GDP per capita of any major country in the world. The large countries that come closest to the US on this score have GDP per capita levels that stand at about 70% of US levels on a nominal basis and slightly higher on a purchasing power parity (PPP) basis. The US dollar is also *the* unquestioned reserve currency of the world; its reserve-currency status has only been fortified after the Eurozone sovereign debt crisis and the British referendum for Brexit. Thus, the US is able to access the excess savings of the entire world. The US also receives the largest share of world foreign direct investment flows, capturing 14% of global flows between 2011 and 2015. The US now accounts for 20% of the stock of all foreign direct investment. Yet, despite all these major advantages, it did not avert a financial crisis in 2008. It defies logic to assume that China will be the one major country that avoids a financial crisis and a hard landing when it does not enjoy such advantages. As we often say, stating that "this

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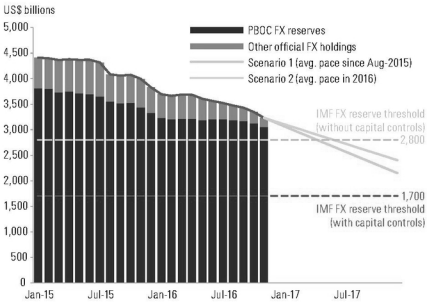
Exhibit 28: Total Foreign Currency Holdings of China's Official Sector

If the recent pace of decline continues, China's reserves could soon fall below the IMF's adequacy threshold.



Data through November 2016.
Source: Investment Strategy Group, CEIC, Bloomberg, IMF.

time is different" is extremely dangerous for the investment well-being of our clients' portfolios.

China, in fact, faces greater risk of a financial crisis because of growing capital outflows. An astounding $1.3 trillion of capital has flowed out of China since August 2015, when it broadened the trading range for its currency against the US dollar. The outflows averaged $64 billion per month in 2016. At that pace, China's total official foreign currency holdings could drop below the IMF's reserve threshold of $2.8 trillion by mid-2017, as shown in Exhibit 28.

Of course, China's leadership has not stood on the sidelines. Since September 2015, the People's Bank of China and the State Administration of Foreign Exchange have introduced a series of measures to limit capital outflows. These measures have included orders to financial institutions to carefully check and strengthen controls on all foreign exchange transactions[91] and strict oversight of Chinese companies' outward investment in overseas property, hotels, cinemas and the entertainment and sports industries.[92] According to reports, leadership has also ordered increased oversight of trade activities to make sure companies are not over-invoicing the value of their imports or under-invoicing the value of their exports as a means of circumventing capital controls.[93] Exports and imports are 20% and 15%, respectively, of China's GDP. It is virtually impossible for China to halt capital flows in such a porous economy without slowing GDP growth rates. Thus, China will not be able to completely stem outflows despite all its measures to slow the pace as much as possible.

Irrespective of the success of such capital controls, China's growing debt problem poses significant risks to China's growth trajectory. We estimate that the risk of a hard landing is only about 25% in 2017 but will increase rapidly to about 50% in 2018 and be closer to 75% in 2019. Therefore, while China is not a near-term risk, there is a high probability of an intermediate-term crisis that will reverberate through financial markets. We also know that we cannot anticipate the exact timing of such crises, especially given the uncertainty of how US-China relations will unfold under a Trump administration.

According to the Center for Strategic and International Studies, China has installed anti-aircraft guns and other weapons systems on seven man-made islands in the South China Sea, including the Johnson Reef, shown above.
Map data: Google, DigitalGlobe

US-China Relations Deteriorate Under the Trump Administration

There is no doubt that US strategy toward China will shift; the only question is when and how. There are two channels by which the Trump administration could affect US-China relations: trade and foreign policy.

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We may see some fireworks in US-China relations during the Trump administration.

With respect to trade, President-elect Trump can use any one of six US statutes, including the Trading with the Enemy Act of 1917 and the International Emergency Economic Powers Act of 1977, to shift trade policy. The latter two statutes give him latitude to change foreign commerce without interference from Congress or the courts.

President-elect Trump has advocated imposing tariffs and labeling China a "currency manipulator." While he has continued to threaten tariffs of 45% on imports from China, there is considerable uncertainty as to what his administration will actually impose. If the US and China engage in a full trade war, the Peterson Institute for International Economics has estimated a notable drag on US GDP growth over three years.[94]

Any of these actions by the Trump administration may provoke a strong reaction from China, including a sizable depreciation of the renminbi. Such depreciation would certainly be disruptive to financial markets.

With respect to foreign policy, many policy experts have been calling for a change in strategy toward China. In April 2015, the Council on Foreign Relations published a special report on China, suggesting that Washington needed "a new grand strategy toward China that centers on balancing the rise of Chinese power rather than continuing to assist its ascendancy."[95] The militarization of the seven artificial islands in the South China Sea (see image on page 33), according to the Asia Maritime Transparency Initiative at the Center for Strategic and International Studies,[96] will only expedite such a shift in strategy.

If President-elect Trump's actions to date, such as the telephone conversation with Taiwan President Tsai Ing-wen[97] and his response to the recent Chinese seizure of a US Navy drone,[98] are any indication, we may see some fireworks in US-China relations during the Trump administration.

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Key Takeaways

As we mentioned in last year's *Outlook*, forecasting is difficult under the best of circumstances but particularly so in the last innings of an eight-year-long economic expansion and bull market. This year brings the additional challenge of a new president whose policies are likely to follow an unconventional script.

Nevertheless, there are seven key takeaways from our 2017 *Outlook*:

- Improving growth: We expect global economic activity to accelerate this year, with modestly higher GDP growth rates in the US, Eurozone, Japan and many emerging market economies. We expect a small slowdown in China.
- Low recession risk: Favorable monetary and fiscal policies substantially reduce the probability of a recession in key developed and emerging market countries.
- Still accommodative monetary policy: US monetary conditions will still be relatively easy because of the slow and steady pace of tightening of the federal funds rate by the Federal Reserve. At the same time, other developed central banks are still expanding their balance sheets.
- Remain vigilant: Despite a favorable economic and policy backdrop, there is no shortage of global risks, including rising populism in Europe, growing geopolitical tensions, the spread of terrorism and the proliferation of serious cyberattacks.
- China concerns: China is the biggest source of uncertainty given its growing debt burden, accelerating capital outflows and potential for a notable deterioration in the US-China relationship driven by changing US trade and foreign policy toward China.
- Stay invested: The collective impact of these various risks is not yet sizable enough to undermine our core view: that we are in a longer-than-normal US recovery that supports equity returns, which are likely to exceed those of cash and bonds. Thus, we recommend staying invested in US equities with some tactical tilts to US high yield bonds and European equities.
- Modest returns: While we recommend clients remain invested, we have modest return expectations. We expect that a moderate-risk well-diversified taxable portfolio will have a return of about 3% in 2017.

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2017 Global Economic Outlook: Winds of Change

FOR MOST OF THE LAST EIGHT YEARS, GLOBAL POLICY MAKERS have been buffeted by the gale force headwinds generated by the financial crisis. In response, central banks around the world have expanded their balance sheets by a staggering $12.5 trillion,[99] while fiscal austerity measures in the G-7 economies have reduced the general government budget deficit from 10% of GDP to just 3.6% today.

Although this mix of policies may have helped avoid a second Great Depression, it has fallen short of fostering a robust economic recovery. According to the IMF, the nominal GDP of advanced economies has grown at just a 1.6% annualized pace in US dollar terms since its 2009 trough, making it among the slowest expansions on record. The overt reliance on monetary policy has also had unintended consequences. Persistently low interest rates have crippled bank profitability and penalized savers. Moreover, the boost that low rates provide to stock prices primarily benefited a narrow segment of the income distribution, exacerbating inequality concerns. Not surprisingly, populism has been on the rise globally.

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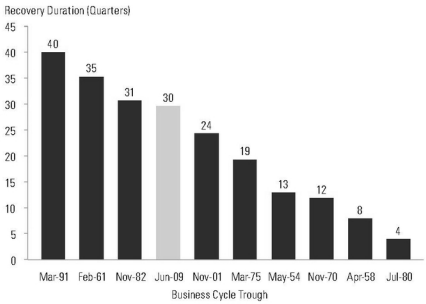
Last year witnessed a growing repudiation of this status quo, evident in the surprise outcome of the UK and Italian referenda, as well as US presidential election. As we begin 2017, these winds of change are gaining force. Central banks are acknowledging the often counterproductive impact of ultra-easy monetary policy and shifting attention to the eventual withdrawal of accommodation. At the same time, the recovery in commodity prices and recent firming in global growth is shifting the focus from deflation to reflation. The same could be said of the increasing focus on expansionary fiscal policy.

While this change brings hope, it also carries risk. In the US, fiscal stimulus arrives eight years into an economic expansion that is already near full employment, increasing the danger of the economy overheating. Although the Federal Reserve could respond by hastening the pace of rate hikes, it might overdo it. Similarly, an overzealous negotiating stance on existing trade relationships or imposition of protectionist policies by the incoming US administration could staunch the flow of trade—an outcome that would be particularly damaging to emerging markets. And in Europe, a victory of the far right in the French presidential election could unleash fears about France exiting the European Union and endanger the survival of the euro.

Still, we do not yet accord a high enough probability to these risks to alter our base case, which assumes these winds of change fill the sails of the ongoing global recovery, rather than capsize it (see Exhibit 29).

Exhibit 30: Duration of Post-WWII Expansions

This expansion is already the fourth-longest since WWII.



Data as of December 2016.
Note: The recovery is measured from the business cycle trough.
Source: Investment Strategy Group, National Bureau of Economic Research.

United States: Age Is Just a Number

The US economic expansion is getting old by historical standards. At nearly eight years, it is already the fourth-longest in post-WWII history and poised to be among the top three by the middle of this year (see Exhibit 30). Concern that the economy's vigor is finally succumbing to its advanced age was only bolstered by anemic 1.6% real GDP growth in 2016, close to the weakest of any year during the recovery.

But as we have argued in the past and as Federal Reserve Chair Janet Yellen recently noted, "it's a myth that expansions die of old age."[100] Instead, business cycles are typically derailed by

Exhibit 29: ISG Outlook for Developed Economies

		United States		Eurozone		United Kingdom		Japan	
		2016	2017 Forecast	2016	2017 Forecast	2016	2017 Forecast	2016	2017 Forecast
Real GDP Growth*	Annual Average	1.60%	1.90–2.70%	1.60%	1.20–1.90%	2.10%	0.50–1.50%	1.00%	0.75–1.50%
Policy Rate**	End of Year	0.75%	1.25–1.50%	0.00%	(0.50)–(0.30)%	0.25%	0.00–0.50%	-0.10%	-0.10%
10-Year Bond Yield***	End of Year	2.44%	2.50–3.00%	0.21%	0.50–1.00%	1.24%	1.50–2.25%	0.05%	0.00%
Headline Inflation****	Annual Average	1.70%	1.80–2.60%	0.60%	0.80–1.60%	1.20%	2.00–3.00%	0.50%	–
Core Inflation****	Annual Average	2.10%	1.80–2.60%	0.80%	0.90–1.40%	1.40%	1.50–2.00%	-0.40%	0.25–1.0%

Data as of December 31, 2016.
Note: The above forecasts have been generated by ISG for informational purposes as of the date of this publication. They are based on ISG's proprietary macroeconomic framework, and there can be no assurance the forecasts will be achieved.
Source: Investment Strategy Group, Goldman Sachs Global Investment Research, Bloomberg.
* 2016 real GDP is based on Goldman Sachs Global Investment Research estimates of year-over-year growth for the full year.
** The US policy rate refers to the top of the Federal Reserve's target range. The Japan policy rate refers to the BOJ deposit rate.
*** For Eurozone bond yield, we show the 10-year German bund yield.
**** For 2016 CPI readings, we show the latest year-over-year CPI inflation rate (November). Japan core inflation excludes fresh food, but includes energy.

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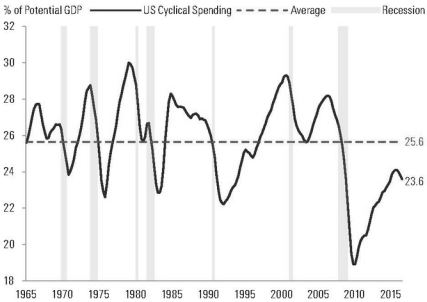
Exhibit 31: US Cyclical Spending

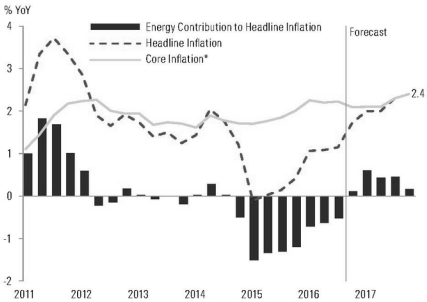
There is scope for business and consumer spending to increase in the US economy.



Data through Q3 2016.
Note: 4-quarter average. Cyclical spending is business fixed investment plus consumer durables spending.
Source: Investment Strategy Group, Datastream.

Exhibit 32: US Inflation

Normalizing energy prices account for much of the inflation increase we expect.



Data as of Q3 2016.
Note: ISG forecasts from Q4 2016. For informational purposes only. There can be no assurance the forecasts will be achieved.
Source: Investment Strategy Group, Datastream.
* Core inflation excludes food and energy.

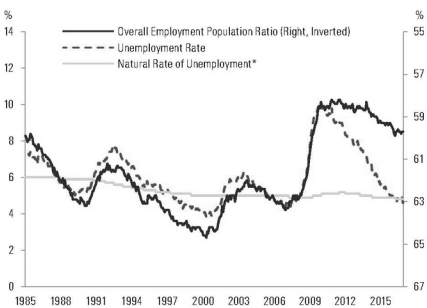
three culprits: economic imbalances, excessive Federal Reserve tightening and/or exogenous shocks (most commonly in the form of spiraling oil prices).

As we survey these risks today, none are particularly alarming. The depth of the financial crisis and the lackluster pace of the recovery have allowed the US to avoid the imbalances that would typically be evident this far into an expansion (see Section I of this year's *Outlook*). If anything, there is scope for spending in cyclical parts of the US economy relative to overall GDP to move toward its long-term average (see Exhibit 31).

There is also less risk of disruptive Federal Reserve tightening, given how few signs we see of economic overheating. Headline inflation remains below the Federal Reserve's 2.0% target, and though we expect it to move higher this year, normalizing energy prices are a key driver (see Exhibit 32). Further, while the November 2016 unemployment rate of 4.6% suggests the economy is near full employment, broader measures of labor slack, as well as today's depressed labor force participation rate, argue that the central bank is not "behind the curve" (see Exhibit 33). Lastly, our expectation for continued modest gains for the US dollar and a rebound in productivity growth from generational lows (see Exhibit 34) provides a natural offset to inflation pressures, even as wages continue to rise.

Exhibit 33: US Unemployment Indicators

There are still signs of slack in the labor market.



Data through November 2016.
Source: Investment Strategy Group, Federal Reserve Economic Data, Datastream.
* Long-term rate.

Of equal importance, the Federal Reserve is acutely aware of the risks that tighter monetary policy poses to the business cycle, which is apparent in both its willingness to step back from planned rate hikes last year as well as Chair Yellen's acknowledgment that an "abrupt tightening would risk disrupting financial markets and perhaps even inadvertently push the economy into recession."[101] With neutral real interest rates

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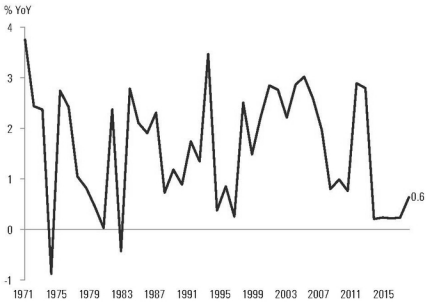
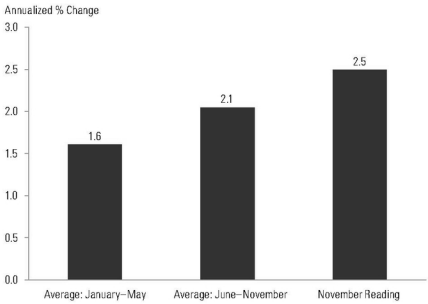
Exhibit 34: US GDP per Hour Worked
We expect a rebound in productivity growth from generational lows.



Data through 2015.
Source: Investment Strategy Group, OECD.

Exhibit 35: Goldman Sachs US Current Activity Indicator
Economic activity accelerated in the second half of 2016.



Data as of November 2016.
Note: The current activity indicator is the first principal component of real-activity indicators, expressed in GDP-equivalent units. This is the growth signal in the main high-frequency indicators for the US economy.
Source: Investment Strategy Group, Goldman Sachs Global Investment Research.

near zero and inflation expectations still below levels compatible with its inflation target, the Federal Reserve is likely to hike rates two or three times in 2017, below the historical average pace. On this point, it is worth remembering that the Federal Reserve originally projected four hikes by the end of 2016, yet enacted only one in December. Thus, even if the Federal Reserve does raise rates three times this year, it will have delivered those four hikes over two years instead of just one.

Lastly, although a recession created by an external shock is always a risk, the probability we place on a hard landing in Europe and/or China or a destabilizing increase in oil prices is not currently high enough to alter our base-case view. Indeed, even with the recent cut in oil production coordinated between OPEC and non-OPEC members, the size of today's oil-supply glut and the historical tendency for producers to exceed their quotas greatly reduce the risk of a price spike (see Section III, Global Commodities). With none of the typical signs of economic contractions flashing red, we accord a 15% probability of a recession in 2017, roughly in line with historical average risk.

Against this backdrop, we expect US real GDP growth to accelerate from last year's moderate 1.6% pace, reaching 1.9–2.7% in 2017. There are three key drivers to this story: fading headwinds, a resilient US consumer and supportive policy. We discuss each below.

With none of the typical signs of economic contractions flashing red, we accord a 15% probability of a recession in 2017.

Fading Headwinds

The combination of falling oil prices and a rising dollar that began in mid-2014 has been a meaningful drag on US growth, with energy-related capital spending falling by more than 60% over this period. In addition, exports have softened, the S&P 500 has suffered almost two years of contracting profits, and inventories throughout the supply chain have ballooned as activity has slowed. Such broad-based weakness has rarely occurred outside a recession.

The silver lining to last year's slowdown, however, is that growth is now poised to improve from depressed levels. A modest recovery in oil prices and stabilization of the dollar enabled US economic activity to accelerate notably in the second half of last year (see Exhibit 35). This boost will be aided

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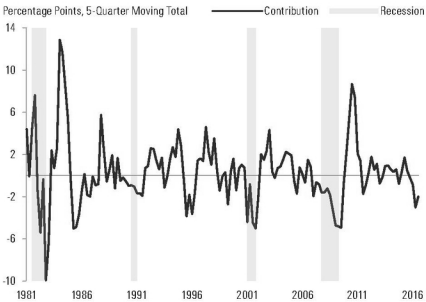
Exhibit 36: Contribution from Change in Inventories to US GDP Growth

Inventories should support growth after five quarters of subtracting from GDP.



Data through Q3 2016.
Source: Investment Strategy Group, Haver Analytics.

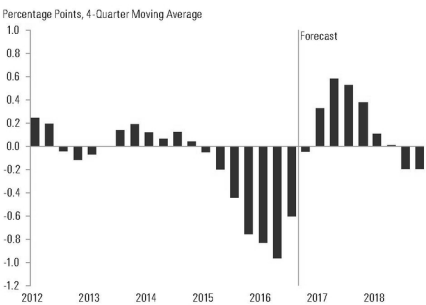
Exhibit 37: National Association of Home Builders US Housing Market Index

The post-crisis high in builder confidence bodes well for US residential investment.

Data through December 2016.
Note: Based on a monthly survey of NAHB members who rate market conditions for the sale of new homes, as well as the traffic of prospective buyers of new homes.
Source: Investment Strategy Group, Datastream.

Exhibit 38: US GDP Growth Impulse from Goldman Sachs Financial Conditions Index

The persistent drag from tight financial conditions over the last two years should reverse in 2017.



Data as of Q3 2016.
Note: The financial conditions index is a weighted average of riskless interest rates, credit spreads, equities and FX, based on effects on 1-year forward US GDP growth. Historical estimates and forecasts by Goldman Sachs Global Investment Research. For informational purposes only. There can be no assurance the forecasts will be achieved.
Source: Goldman Sachs Global Investment Research.

by inventory restocking, which looks ready to help GDP growth again after five quarters of negative contributions (see Exhibit 36). Similarly, residential investment is set to contribute, reflected in the National Association of Home Builders (NAHB) housing market index reaching a post-crisis high in December of last year (see Exhibit 37). Overall, we expect this momentum to continue as the erstwhile easing in financial conditions provides a growth tailwind throughout 2017 (see Exhibit 38).

A Resilient US Consumer

The stars are aligned for US consumers in 2017, as they enter the year with rising wages, higher net worth from asset price gains, historically low debt-servicing costs, ample savings and confidence at a 12-year high. They also stand to benefit directly from potentially lower tax rates and indirectly from higher fiscal spending, a topic we discuss in the next section. The above-mentioned factors should mitigate the headwind from higher inflation. Overall, we expect private consumption—a key driver of our GDP forecast—to expand at a pace of approximately 2.5%.

Supportive Policy

While government policy is always a source of uncertainty, it is even more so in 2017 given potential changes to tax, trade and immigration policies in the wake of last year's presidential election. Nonetheless, our base case is that policy ultimately supports growth this year, with some fiscal expansion and a measured pace of Federal Reserve rate hikes. Although the final contours of

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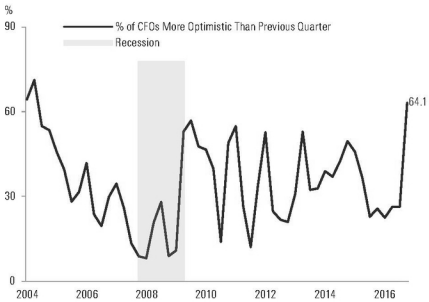
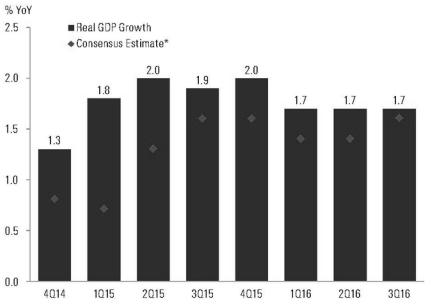
Exhibit 39: CFO Optimism About the US Economy
Chief financial officers' confidence is at its highest level in a decade.



Data through December 2016.
Note: The survey questionnaire is delivered online to senior financial executives and subscribers of *CFO Magazine* from both private and public companies.
Source: Investment Strategy Group, Haver Analytics.

Exhibit 40: Eurozone Real GDP Growth
Economic activity has been surprisingly resilient and higher than expected.



Data through Q3 2016.
Source: Investment Strategy Group, Bloomberg.
* One quarter prior to release.

the new administration's policies remain uncertain, a moderate-sized stimulus package of around $200 billion per year seems likely.[102] While the *direct* impact of such a package is estimated to boost GDP growth by only 0.3 percentage point in 2017, the positive *indirect* impact of tax cuts and stronger anticipated GDP on household and business confidence is arguably more important. Indeed, both consumer and CFO confidence have recently hit their highest readings in over a decade (see Exhibit 39).

Our View on US Growth

As the expansion enters its eighth year, it is natural to question its durability. But far from showing its age, the US economy begins 2017 at an above-trend growth pace, with little evidence of cyclical imbalances or other excesses that typically portend the end of the business cycle. If anything, the slow pace of this recovery has elongated its life span, a dynamic that is likely to persist this year. Perhaps in macroeconomics, as in life, age is just a number.

Eurozone: Weathering the Storm

The Eurozone has faced its share of challenges in recent years. Not only did it relapse into recession in 2011, but it also endured a domestic sovereign bond and banking crisis at the same time. More recently, it has been buffeted by a spate of tragic terrorist attacks, an immigration crisis, the Brexit vote, a failed Italian constitutional referendum and renewed concerns about the solvency of its banking system.

Yet despite this onslaught of headwinds, the real economy has been remarkably stable in the last two years. That fact is evident in Exhibit 40, which shows real GDP growth has sustained an above-trend pace over this period, an outcome that clearly exceeded consensus forecasts. Business sentiment has remained equally steadfast over this period, suggesting that the rapidity of shocks may have effectively inured confidence to bad news (see Exhibit 41). Meanwhile, real household disposable income grew by 2.3% over the past year—the fastest pace since 2007.

We expect this stability to persist in 2017, with our forecast calling for 1.2–1.9% real GDP growth. Keep in mind that there is ample scope for above-trend growth to continue, as the level of Eurozone GDP still stands below its potential. On this point, the OECD, IMF and European Commission each currently estimate an output gap of around 2%, indicating slack in the economy. The Eurozone's still elevated 9.8% unemployment rate corroborates this point.

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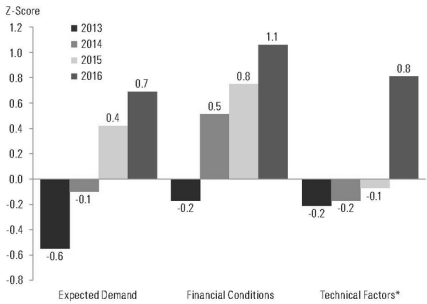
Exhibit 41: European Commission Industrial Confidence Survey

Eurozone business sentiment has remained steady despite recent shocks, including Brexit.

Data through November 2016.
Source: Investment Strategy Group, Datastream.

Exhibit 42: Drivers of Eurozone 2-Year Capital Spending Plans

Key factors that influence business investment stand at their highest levels in years.



Data through 2016.
Note: Based on the European Commission investment survey.
Source: Investment Strategy Group, Datastream.
* Technical factors include technological developments, the availability of labor and government incentives to invest.

As a result, Eurozone policy is likely to remain accommodative, keeping financial conditions supportive of growth. While we expect the European Central Bank (ECB) to gradually shift to a more neutral stance that is less punitive to bank profitability and acknowledges the uptrend in headline inflation, this shift does not imply the removal of accommodation. Indeed, the ECB has already announced an extension of quantitative easing through December 2017. Meanwhile, the European Commission has endorsed a moderate fiscal easing of 0.5% of GDP for the Eurozone. Given that fiscal policy is typically loosened ahead of major elections, this guidance could soon be embraced in France and Germany.

Of equal importance, both consumption and business investment are well positioned as we enter 2017. On the former, continued improvement in the labor market and ongoing GDP growth should encourage consumers to spend a bit from their precautionary savings, particularly given today's relatively high savings rate. At the same time, the fundamental justifications for increased business spending, such as higher demand and easy credit conditions, stand at their best levels in years (see Exhibit 42). Perhaps not surprisingly, a late 2016 survey of manufacturing firms revealed their investment intentions stood at all-time highs.[103]

Of course, ongoing uncertainty regarding Brexit, the banking sector and upcoming elections remains a potential downside risk, particularly for an investment recovery. As a result, we acknowledge a greater-than-normal range of potential outcomes, both positive and negative. For example, the victory of the far right in the French presidential election could unleash fears about France exiting the European Union and endanger the survival of the euro, while the new government in Italy could speed up the long-overdue resolution of the banking sector's problems and change the electoral law to reduce political uncertainties.

For now, our base case assumes that Italy will avoid a populist party in government and that a centrist candidate will win the French presidential election. Thus, we expect the Eurozone to again weather the storm in 2017.

Ongoing uncertainty regarding Brexit, the banking sector and upcoming elections remains a potential downside risk.

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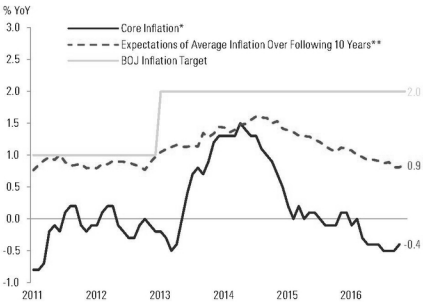
Exhibit 43: Japan Consumer Prices

Core inflation and inflation expectations remain low.



Data through November 2016.
Source: Investment Strategy Group, Datastream, QUICK Bond Investors Survey.
* Core inflation excludes fresh food and VAT impact.
** Based on the QUICK Bond Investors Survey.

United Kingdom: A Fork in the Road

Much like the Eurozone, the UK economy is notable for its resilience, evident in 15 consecutive quarters of positive quarterly growth averaging 2.5% annualized. This streak is even more impressive considering last year's Brexit vote and the resulting consensus view that the UK was destined for recession. Although the 20% decline in the trade-weighted sterling and rapid easing by the Bank of England were no doubt pivotal in avoiding that fate, the immediate impact of the Brexit referendum has been far less destructive than feared.

But as we begin 2017, the UK is rapidly approaching a fork in the road. The government must choose which path Brexit will take once it triggers Article 50 of the Lisbon Treaty, which formally sets the process of the UK exit in motion. Here, the government's current objectives—limiting freedom of movement into the UK while retaining full access to the European Union's single market—seem mutually exclusive and likely to engender a politically charged negotiation process. This road is made all the more dangerous by the fact that UK authorities will have little room to cushion a downturn given today's large fiscal deficits and already highly accommodative central bank. Of course, a softer stance on the issues is also a possible path, one that could elongate the effective transitional period beyond two years and lead to a far more benign outcome for the UK.

The uncertainty around the government's ultimate choices significantly increases the range of GDP outcomes in the medium term. Our current base case assumes GDP will expand by 0.5–1.5% in 2017. This notable slowdown from last year's 2% pace reflects the likelihood that both hiring and investment activity will become more cautious once the Brexit negotiations start. Even worse, this slowdown arrives just as consumer price inflation is accelerating from past sterling depreciation, creating a lower growth/higher inflation backdrop that is set to erode real income growth. For these reasons, the risks to our central case are skewed to the downside.

That said, the fate of the UK economy is not preordained, even after the government chooses its path. As with any other negotiation, the result will ultimately reflect the reasonableness of the parties, the concessions of both parties and how the discussions evolve over time. Or in the words of golf legend Arnold Palmer: "The road to success is always under construction."[104]

UK authorities will have little room to cushion a downturn given today's large fiscal deficits and already highly accommodative central bank.

Japan: Same Battle, Different Year

For Japan, the decades-long battle against deflation never seems to end. Despite two years of above-trend GDP growth, including last year's 1% gain, core inflation remains negative, having fallen 0.4% in 2016 (see Exhibit 43). This comes despite a tight labor market and record profits that should have encouraged companies to increase base wages. These already muted inflationary pressures were exacerbated by low energy prices and the appreciation of the yen, once again pushing the Bank of Japan's (BOJ's) 2% inflation target further into the future.

But far from waving the white flag, Japan's policymakers responded with a range of bold measures, including a

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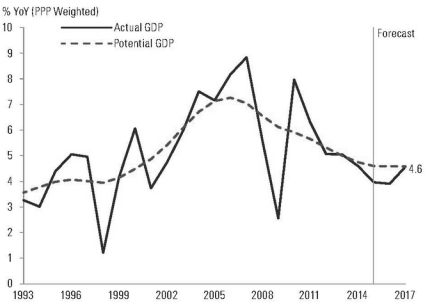
Exhibit 44: Emerging Market GDP Growth
We expect growth roughly in line with potential.



Data as of 2016.
Note: ISG forecasts for 2016–17. For informational purposes only. There can be no assurance the forecasts will be achieved.
Source: Investment Strategy Group, IMF.

large fiscal stimulus package last August and a shift by the BOJ away from ever-higher purchases of Japanese government bonds (JGBs). Instead, the BOJ will now use a "yield-curve control" framework, wherein it sets the short rate and targets a yield of about 0% on 10-year JGBs. This novel approach should afford the government low real interest rates with which to finance its fiscal expansion, while also providing Japanese financial institutions with a sufficiently steep yield curve to remain profitable. To augment these deflation-fighting measures, the government also implemented some modest structural reforms and called for a substantial increase in the minimum wage in order to support faster income growth.

Against this backdrop of supportive policies, we expect that GDP will grow by 0.75–1.5% in 2017. Our forecast is supported by three key drivers. First, the fiscal stimulus announced in August is poised to contribute 0.4 percentage point to 2017 GDP growth, and the government has indicated a willingness to do more if necessary. Second, the BOJ remains very accommodative, thereby providing easy financial conditions that should foster an uptick in business investment. While the central bank may consider a modest rate increase in late 2017, we expect it to maintain its negative interest rate policy (NIRP) for short rates and a 0% target for 10-year JGB yields in the interim. Lastly, the government is likely to push for further wage increases during the spring wage negotiations.

These pro-growth policies, coupled with less slack in the economy and a boost from higher energy prices and past yen appreciation, should enable core inflation (excluding fresh food) to reach our expected range of 0.25–1.0%. While Japan may have lost its battles against deflation over the years, it has not yet lost the war.

Emerging Markets: Competing Forces

Emerging market economies failed to live up to expectations once again in 2016, with GDP expanding by an estimated 3.9% versus original expectations closer to 5.0%. This marked the second-slowest growth rate in 15 years; only the 2.6% expansion at the depth of the global financial crisis in 2009 was slower. Yet this disappointing headline belies the economic recovery that unfolded over the course of 2016. Consider that growth actually troughed during a challenging first quarter, with economic activity gradually improving thereafter on the back of recovering commodity prices, the Federal Reserve's willingness to delay any further rate hikes and stable Chinese growth. These tailwinds were bolstered into the final quarter by early signs of recovery in Brazil and Russia, both of which had suffered deep recessions in 2015.

We expect this momentum to persist, with GDP increasing by 4.3–4.8% (purchasing power parity [PPP] weighted) this year, roughly in line with potential (see Exhibit 44). The pickup we expect is the product of two opposing forces. On the one hand, growth should benefit from the ongoing recoveries in Brazil and Russia, and somewhat stronger activity in developed economies should provide a small tailwind to emerging market exports. On the other hand, the further moderation in Chinese growth we expect is likely to weigh on activity across emerging markets, particularly if the US imposes tariffs.

Indeed, the policy agenda of the incoming US administration remains a critical unknown for emerging markets. Even if protectionist tariffs were directed only at China and Mexico—which account for 23% and 15% of US imports of manufactured goods, respectively—they would still negatively impact all emerging markets given the sensitivity of these countries to Chinese growth and fluctuations in the Chinese currency. This being the case, countries with substantial trade exposure to

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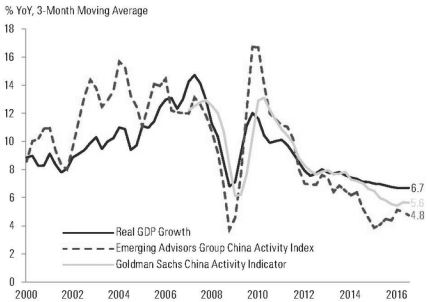
Exhibit 45: China Economic Activity Measures
Actual growth is likely lower than official figures.



Data through Q3 2016.
Source: Investment Strategy Group, Emerging Advisors Group, Goldman Sachs Global Investment Research.

both China and the US, such as Korea, Taiwan and Malaysia, would be particularly vulnerable.

While the net effect of these competing forces is positive in our base case, the risks are tilted to the downside.

China

China continues to drive its economy with one foot on the gas pedal and the other on the brake. Consider that the government reached its official GDP growth target of 6.5–7% last year only by increasing public spending and allowing rampant credit growth. But these measures also exacerbated real estate bubble concerns and hastened capital outflows, forcing the government to apply the brakes through new restrictions within the property market and more stringent capital controls. This focus on dual-footed driving has also come at the expense of much-needed structural reforms. As a result, China continues to suffer from considerable excess capacity in industrial sectors, such as steel and coal, while its financial sector risks have increased.

Even so, we expect this approach to continue in 2017. Structural reforms are likely to stay on the back burner because China's leaders will not risk slower growth ahead of important leadership changes at the 19th Communist Party of China National Congress in the fall. In turn, the government is likely to use further fiscal easing and rapid credit expansion to target growth of around 6.5%. As a result, we expect official GDP to expand by 6.0–6.75% in 2017, although actual GDP growth will likely be lower (see Exhibit 45).

The risks to our outlook are skewed to the downside for two reasons. First, the new direction of US trade policy remains uncertain and could have a sizable impact. For instance, a 15% tariff would mechanically reduce China's GDP by 0.9%. China could respond by ramping up leverage, letting its currency depreciate faster and injecting more fiscal stimulus, but that could risk further imbalances in the economy while also disrupting global financial markets. Second, striking the right balance between stimulative and contractionary measures is a hazardous endeavor. On the road, as in government policy, accelerating and braking at the same time greatly increases the risk of an accident.

India

India's streak of strong growth continues. The economy expanded by an estimated 6.5% in 2016, making it the fourth consecutive year of GDP growth in excess of 6.0%, a rare feat that India's economy shares only with China's. Growth would likely have been even higher, were it not for the "demonetization" scheme the government introduced in November 2016. In a surprise move, the government announced that large-denomination bank notes, representing 86% of cash in circulation, would no longer be accepted as legal tender. The scheme—intended to root out illegal income stored in cash—had the unfortunate side effect of starving households of liquidity and thereby thwarting consumption, the main engine of growth. Although the severity of the consumption shock remains uncertain, it should be temporary.

The silver lining for 2017 is that India will probably benefit from a meaningful recovery in household spending. Moreover, fiscal policy will likely be eased ahead of the 15 state elections occurring in 2017 and 2018, while investment should receive a modest boost as the Reserve Bank of India lowers borrowing costs. Accordingly, we expect GDP growth of 6.5–7.5% in 2017.

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China continues to suffer from considerable excess capacity in industrial sectors, such as steel and coal, while its financial sector risks have increased.

Brazil

Brazil has had its share of hard times in recent years. After being among the fastest-growing economies in the world in 2010, it has more recently suffered its worst recession in a century, evident in seven consecutive quarters of contraction. In turn, GDP fell an estimated 3.3% last year, leaving it on par with 2010 levels. Even worse, industrial production now stands where it did in 2004.

Fortunately, there are already tentative signs of a recovery. Inflation has peaked; the current account deficit has shrunk; and confidence indicators, while still weak, have stabilized. Of equal importance, the financial markets have welcomed a new government amid expectations that it will finally tackle Brazil's fiscal problems and steer the economy out of recession.

But despite these promising green shoots, our base case does not call for a robust recovery in 2017. While the new administration is off to a promising start, it is facing resistance to key structural reforms while also navigating ongoing corruption probes. Moreover, the recovery in household consumption and business investment is likely to be hamstrung by continuing high real interest rates, a function of falling inflation and a simultaneously easing central bank. Meanwhile, fiscal policy will continue to tighten given a new spending cap and proposed pension reform measures. Finally, the modest commodity price gains we expect are unlikely to foster a meaningful rise in exports for Brazil. Accordingly, we expect a tepid recovery, with GDP expanding just 0–1% in 2017.

Russia

Russia is also slowly recovering from a deep recession. Although the economy contracted for its second consecutive year in 2016, headwinds are now receding thanks to a recovery in real wages, rising oil prices and a related increase in oil production. The economy has also received support from both fiscal and monetary policy, with the central bank cutting the policy rate by 100 basis points last year as inflation moderated. Still, the economy has likely suffered some permanent damage from the combination of depressed oil prices and Western sanctions, which have pushed down Russia's long-run growth potential.

While the cyclical recovery should continue in 2017, it is apt to be measured. The government is planning to reduce the fiscal deficit by 1% of GDP this year, which will limit fiscal support. That said, elections in March 2018 could ultimately temper such fiscal prudence. Meanwhile, the central bank will likely deliver more rate cuts, but their size and pace will depend on the path of inflation, which could be stickier than anticipated.

Against this uncertain backdrop, we expect the Russian economy to return to modest growth in 2017, expanding 0.5–1.5%. While not our base case, growth could quicken if oil prices increase more than we expect or if sanctions are lifted.

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2017 Financial Markets Outlook: The Horns of a Dilemma

INVESTORS HAVE HAD AN AMAZING BULL RUN. Including last year's 12% total return, the S&P 500 is nearly 3.5 times as high as its financial crisis trough. The advance has been equally long-lasting, second in length only to the almost-decade-long period that preceded the technology bubble in 2000. These impressive gains are not limited to just equities or US assets. US corporate high yield has gained 177% over the same time span, while the total return of the MSCI All Country World Index excluding the United States has been higher only 5% of the time over comparable eight-year periods since 1994.

But as we begin a new year, these gains have left investors on the horns of a dilemma. Put simply, they must now choose to either remain invested at high valuations and bear the associated risk of loss or exit the market and forgo the potential for upside surprises as well as returns that are attractive compared to the alternatives.

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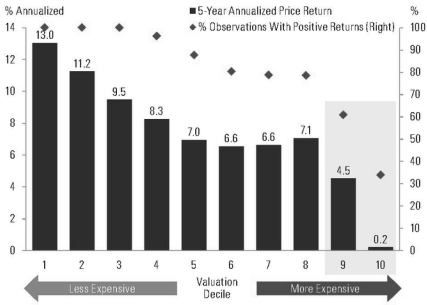
To be sure, there are good reasons to be cautious, as we discussed in Section I, The Risks to Our Outlook. Even worse, investors are exposed to these dangers at a time when most asset valuations are expensive by historical standards, providing them with a narrow margin of safety to absorb such adverse developments. This is particularly true in the US, where valuations have been cheaper at least 90% of the time historically.[105] Even in Europe, where valuations are more attractive, that fact is counterbalanced by greater geopolitical risks and deeper structural fault lines.

Still, as we highlighted in Section I of this *Outlook*, there are three reasons why remaining invested in risk assets is still warranted despite what are likely to be uninspiring returns. First, we see only a 15% probability of a US recession, which has historically been the key driver of losses in risk assets. Indeed, the S&P 500 has generated positive annual total returns 86% of the time during economic expansions in the post-WWII period. Second, the comparable returns of investment alternatives—such as cash and bonds—are unappealing, particularly in the rising interest rate environment that we expect. Third, risk assets can surprise us to the upside, as last year demonstrated. The potential for returns to exceed our expectations is especially true in the US, given the possibility of tax reforms, fiscal expansion and deregulation. The same could be said for our tactical positions across various asset classes, which we discussed in Section I, Our Tactical Tilts.

While we have suggested that the dilemma should be resolved in favor of remaining invested, we are not Pollyannaish. Investors have ridden this bull market for eight years, and while we don't expect the ride to end in 2017, we must stay vigilant to avoid the horns.

Exhibit 47: US Equity Price Returns from Each Valuation Decile

In the past, subsequent returns from high valuation levels have been muted.



Data as of December 31, 2016.
Note: Based on 5 valuation metrics for the S&P 500, beginning in September 1945: Price/Trend Earnings, Price/Peak Earnings, Price/Trailing 12m Earnings, Shiller Cyclically Adjusted Price/Earnings Ratio (CAPE) and Price/10-Year Average Earnings. These metrics are ranked from least expensive to most expensive and divided into 10 valuation buckets ("deciles"). The subsequent realized, annualized 5-year price return is then calculated for each observation and averaged within each decile. Past performance is not indicative of future results.
Source: Investment Strategy Group, Bloomberg, Datastream, Robert Shiller.

US Equities: Life in the Fast Lane

US stocks have been driving in the fast lane since 2009. Over this nearly eight-year period, the S&P 500 has generated a stunning 16.5% annualized price return, a pace exceeded only 3% of the time since 1945. As a result, the 500 companies in the index are collectively worth $20 trillion today, about 3.5 times as high as they were at the trough of the financial crisis. Needless to say, investors have had a good ride.

Yet such a fast drive also raises the question of whether US equities are now running on empty.

Exhibit 46: ISG Global Equity Forecasts—Year-End 2017

	2016 YE	End 2017 Central Case Target Range	Implied Upside from Current Levels	Current Dividend Yield	Implied Total Return
S&P 500 (US)	2,239	2,225–2,300	-1–3%	2.1%	1–5%
Euro Stoxx 50 (Eurozone)	3,291	3,250–3,400	-1–3%	3.6%	2–7%
FTSE 100 (UK)	7,143	7,050–7,310	-1–2%	4.0%	3–6%
TOPIX (Japan)	1,519	1,530–1,590	1–5%	1.9%	3–7%
MSCI EM (Emerging Markets)	862	880–925	2–7%	2.6%	5–10%

Data as of December 31, 2016.
Note: Forecast for informational purposes only. There can be no assurance that the forecasts will be achieved. Please see additional disclosures at the end of this *Outlook*.
Source: Investment Strategy Group, Datastream, Bloomberg.

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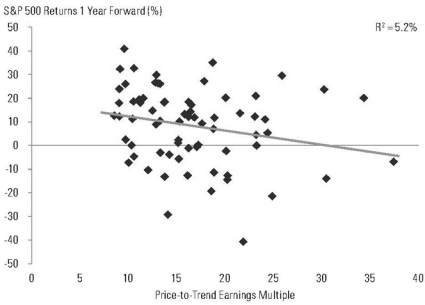
Exhibit 48: S&P 500 Price-to-Trend Earnings vs. Subsequent Calendar-Year Price Return

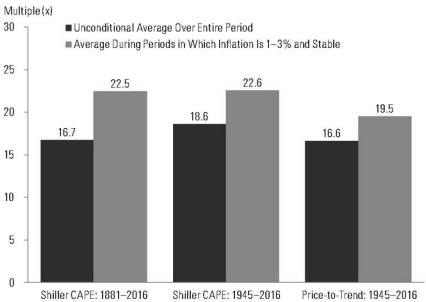
Starting valuation multiples tell us little about equity returns over the following year.



Data as of December 31, 2016.
Source: Investment Strategy Group, Bloomberg, Datastream, Robert Shiller.

Exhibit 49: S&P 500 Valuation Multiples by Inflation Environment

Periods of low and stable inflation have supported higher equity multiples.



Data as of December 31, 2016.
Source: Investment Strategy Group, Bloomberg, Datastream, Robert Shiller.

This bull market is already quite old by historical standards, second in length only to the almost 10-year period that preceded the technology bubble in 2000. Moreover, valuations now stand in their 10th decile, indicating they have been cheaper at least 90% of the time historically. In the past, starting from such a high base has led to muted equity returns over the subsequent five years, with only a third of those episodes generating a profit (see Exhibit 47).

Even so, high valuations should not be confused with certainty of loss, especially over short periods. As seen in Exhibit 48, today's equity multiples tell us very little about potential gains over the next year, explaining only 5% of their variation historically. Moreover, history teaches us that a strategy of selling equities based solely on expensive valuations has been a losing approach over time. As we noted in our 2014 *Outlook*, research conducted by three professors at the London Business School concluded that underweighting equities based exclusively on high valuations underperformed a strategy of remaining invested across every one of the 20 countries and three country aggregates they examined.[106] In short, valuations alone are a poor tactical timing signal. Indeed, the S&P 500 has returned more than 36% since first entering its 9th valuation decile in November 2013, a time when many were already suggesting that US equities were in a bubble.

Valuations must also be considered in the context of the prevailing macroeconomic environment. Consider that periods of low and stable inflation, such as we expect for the year ahead, have supported higher valuations in the past (see Exhibit 49). The same could be said for lower taxes and deregulation—were they to materialize later this year—as both would boost real returns on invested capital and justify higher equity values. Similarly, today's structurally lower interest rates—reflecting slower population and productivity growth—reduce the rate at which all future cash flows are discounted, increasing their present value.

Here, it's helpful to remember that the S&P 500's long-term average P/E ratio—which many investors use to gauge fair value—was forged over a period when risk-free rates averaged 4.5%. In contrast, the risk-free rate now is just 0.5–0.75% and the Federal Reserve

Investors have ridden this bull market for eight years, and while we don't expect the ride to end in 2017, we must stay vigilant to avoid the horns.

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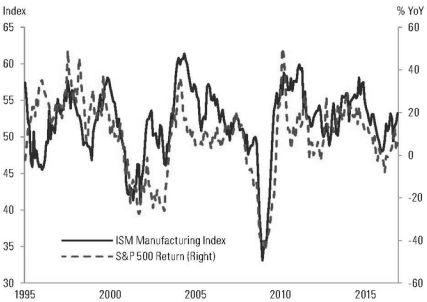
Exhibit 51: ISM Manufacturing Index and S&P 500 Returns

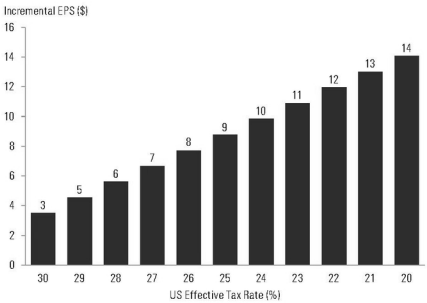
Equity market performance is closely related to the business cycle.



Data through November 30, 2016.
Source: Investment Strategy Group, Bloomberg.

Exhibit 52: Estimated Incremental S&P 500 Earnings per Share by Tax Rate

Proposals for lower corporate tax rates could lead to higher earnings.



Data as of December 31, 2016.
Note: The current US effective tax rate for the S&P 500 companies is 33.3%.
Source: Investment Strategy Group, Standard & Poor's.

estimates its new long-run equilibrium level has fallen to 3%, a full 1.5 percentage points below the historical average.[107] Of equal importance, the Federal Reserve is not expected to reach that 3% target for six years based on current market pricing in Eurodollar futures.

A similar valuation tailwind emerges from the market's current sector composition. The combined technology and health-care sectors constitute about 40% of S&P 500 earnings today, almost three times as high as their 15% share in the late 1980s. Because these faster-growing, higher-margin sectors are generally accorded premium valuations, their higher representation in the index today justifies a higher S&P 500 P/E multiple.

Although current valuations may be fundamentally justified, that does not mean they are impervious to downward pressure. Our central-case equity view for 2017 acknowledges this, calling for some contraction in P/E multiples given the uncertainty associated with a new administration and continued Federal Reserve interest rate hikes. Even so, that headwind will be more than offset by the 6–10% earnings growth we forecast, resulting in a 1–5% total return for US equities this year (see Exhibit 50).

Investors might rightly ask whether it is worth bearing equity risk for such meager returns. Our read of the evidence suggests it is. The linchpin of this view is our expectation of a continued

Exhibit 50: ISG S&P 500 Forecast—Year-End 2017

2017 Year-End	Good Case (25%)	Central Case (60%)	Bad Case (15%)
End 2017 S&P 500 Earnings	Op. Earnings $140 Rep. Earnings $124 Trend Rep. Earnings $113	Op. Earnings $125–130 Rep. Earnings $113–117 Trend Rep. Earnings $113	Op. Earnings ≤ $102 Rep. Earnings ≤ $78 Trend Rep. Earnings ≤ $113
S&P 500 Price-to-Trend Reported Earnings	21–23x	18–21x	15–16x
End 2017 S&P 500 Fundamental Valuation Range	2,375–2,600	2,040–2,375	1,700–1,810
End 2017 S&P 500 Price Target (based on a combination of trend and forward earnings estimate)	2,450	2,225–2,300	1,800

Data as of December 31, 2016.
Note: Forecasts and any numbers shown for informational purposes only and are estimates. There can be no assurance the forecasts will be achieved and they are subject to change. Please see additional disclosures at the end of this *Outlook*.
Source: Investment Strategy Group.

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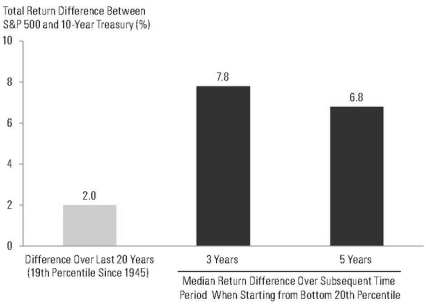
Exhibit 53: US Equity Performance Relative to Fixed Income

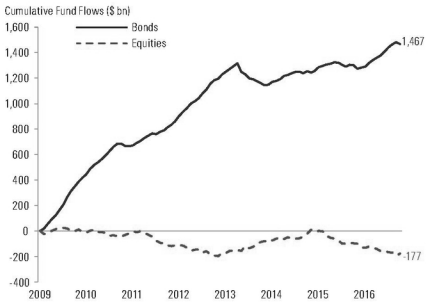
Stocks have outperformed bonds following periods of muted return differences.



Data as of December 31, 2016.
Source: Investment Strategy Group, Bloomberg, Leuthold Group.

Exhibit 54: US Equity and Bond Fund Flows

Equities could benefit from rebalancing out of bonds given lopsided flows since 2009.



Data through November 30, 2016.
Note: Beginning in March 2009.
Source: Investment Strategy Group, Bloomberg, ICI.

expansion in the US economy (see Section II, United States). The state of the business cycle is a key driver of market performance, evident in the tight linkage between the S&P 500 and the ISM Manufacturing Index (see Exhibit 51). Notably, the S&P 500 has generated positive annual total returns 86% of the time during economic expansions in the post-WWII period, while suffering annual declines of greater than 10% just 4% of the time. During the same postwar period, nearly three-fourths of the bear markets—defined here as declines of 20% or more—occurred during US recessions.

With few signs of an economic contraction on the horizon, the high odds of positive returns and low odds of large losses raise the hurdle for underweighting equities significantly. This is particularly true because the risks are not one-sided: markets often surprise to the upside, too, even at high valuations. Last year was a case in point: the S&P 500's 12% return matched our good-case scenario, although at the start of 2016 we had attached only 20% odds to it occurring.

As we consider the potential for similar upside surprises in 2017, earnings growth tops the list for three reasons. First, we expect the sizable profit drag from energy earnings to reverse in 2017, with scope for a greater than $4–5 contribution to S&P 500 EPS if recently announced global oil production cuts are realized. Keep in mind that this contribution was closer to $15 prior to the collapse in oil prices. Second, a shift to a 25% corporate tax rate could add $9–10 to S&P 500 EPS in 2017 if enacted retroactively (see Exhibit 52). Finally, a tax holiday for the estimated $1 trillion of cash held overseas could lead to an additional $1–2 of EPS upside from repatriation-driven buybacks.

There are also other, less visible potential catalysts for equities. Over the last 20 years, the total return of stocks has exceeded that of 10-year Treasury bonds by only 2 percentage points, well below the historical average of 4.4 percentage points and a result that ranks in the bottom 20% of all post-WWII observations. But after similar periods of underperformance, stocks generated well above average relative returns over the next three and five years (see Exhibit 53). Said differently, history suggests stock returns will outpace those of bonds, even if expected equity returns are uninspiring.

A related source of upside stems from the lopsided investor flows evident in Exhibit 54. Here, even moderate rebalancing out of bonds by retail investors—who represent 80% of mutual fund owners—would represent a sizable tailwind to equities. Historically, a shift in flows from bonds into equities has been motivated by three factors: confidence in the durability of the economic recovery, unattractive prospects for bond returns and higher equity prices (see Exhibit 55). Our central case features all three factors, suggesting the

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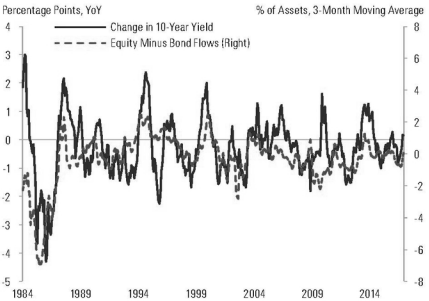
Exhibit 55: US Equity Fund Flows and Change in 10-Year Treasury Yield

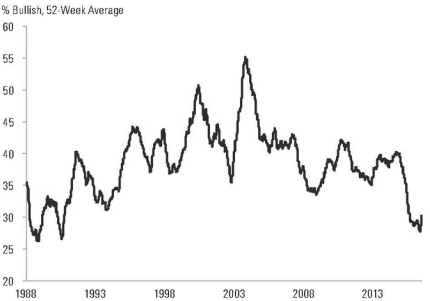
Bond returns can influence flows into equity funds.



Data through December 31, 2016.
Source: Investment Strategy Group, Bloomberg, ICI.

Exhibit 56: The AAII Bullish Investor Sentiment

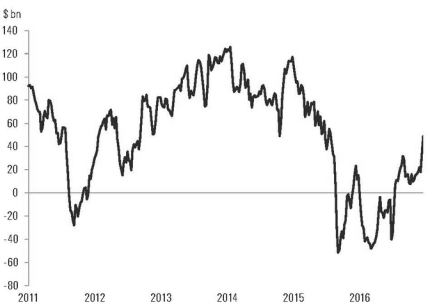
Lack of investor euphoria is a contrarian positive for stocks.



Data through December 31, 2016.
Source: Investment Strategy Group, Bloomberg, American Association of Individual Investors.

Exhibit 57: Non-Dealer US Equity Index Futures Positioning

There is scope for increased US equity positions.



Data through December 31, 2016.
Source: Investment Strategy Group, CFTC, Goldman Sachs Securities Division Equity Strats Group.

incipient uptick in bond outflows seen in late 2016 may persist, especially with "risk-free" Treasuries delivering a notable loss in the fourth quarter.

Today's visible lack of market euphoria represents another potential positive for stocks. Exhibit 56 shows the proportion of investors classifying themselves as "bullish" near its lowest level in decades. Meanwhile, non-dealer positions in US index futures stand well below the levels seen in 2013–14, providing scope for upside (see Exhibit 57). If bull markets "die on euphoria" as Sir John Templeton observed, then these measures argue we have not yet reached the apex.

A rare technical analysis signal corroborates that view. As shown in Exhibit 58, the Coppock curve—an intermediate-length momentum signal—has generated only 17 buy signals over the past 71 years, but collectively they have provided attractive low-risk entry points for long-term investors. If we took the median path of S&P 500 prices after past signals, it would imply the market gains 9% this year with 88% odds of a positive outcome. Of particular note, Coppock buy signals on the NYSE, Russell 2000 and FTSE All-World Index were also triggered in November, even before the post-election rally. For all the reasons discussed above, we accord a 25% probability to our good-case scenario of the S&P 500 reaching 2,450 by year-end.

Of course, we are equally aware of the myriad downside risks investors face, including growing unease about a disorderly backup in bond yields. But here, our work suggests that rates have scope to increase further before becoming a headwind for stocks, even if adjusted for today's lower long-run equilibrium nominal rate (see Exhibit 59). Keep in mind that 88% of S&P 500 debt has a fixed interest rate and only about 10% matures each year. The impact of higher rates will be spread over many years as a consequence.

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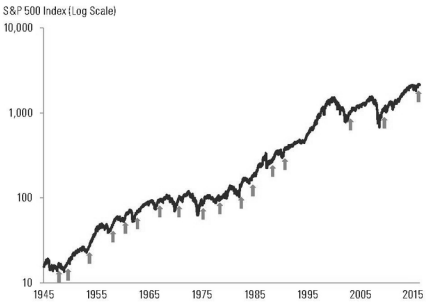
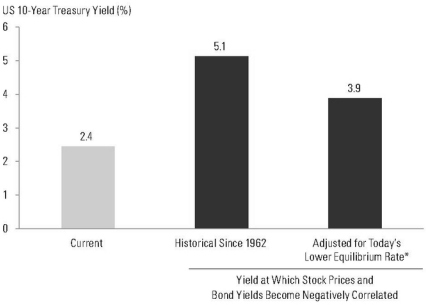
Exhibit 58: Coppock Curve S&P 500 Buy Signals
One of only 17 post-WWII buy signals was triggered in July 2016.



Data through December 31, 2016.
Source: Investment Strategy Group, Bloomberg.

Exhibit 59: Inflection Point for Negative Correlation Between Bond Yields and Stock Prices
Typically stocks and interest rates move in the same direction until yields reach levels far above those seen today.



Data as of December 31, 2016.
Source: Investment Strategy Group, Bloomberg, Federal Reserve.
* Adjusts for the reduction of 1.25 percentage points in the long-run equilibrium nominal rate, in line with the shift in Federal Reserve projections since 2012.

Some have taken a less sanguine view, arguing that the "taper tantrum" of 2013 suggests bond yields have already reached a troublesome level for stocks. However, the tantrum primarily reflected concerns that by tightening policy prematurely, the Federal Reserve was committing a mistake that would undermine growth—a fact evident in the episode's widening credit spreads and declining breakeven inflation rates. Despite a similarly rapid increase in rates this time around, we have seen the opposite market reaction, with credit spreads tightening and breakeven inflation rates moving higher alongside growth expectations. This contrast reminds us that the reason rates are increasing is as important as their resulting level.

Aside from rates, ongoing concern about a hard landing in China and a banking or political crisis in Europe remain top of mind (see Section I, The Risks to Our Outlook). We also start the year with less of a buffer to absorb such adverse developments, given today's high valuations. Even worse, this narrower margin of safety arrives at a time when policy uncertainty in the US is particularly acute, given upcoming changes to tax, trade and immigration policies under the new administration. A destination tax, for example, could be particularly damaging to S&P 500 margins given the growth of global supply chains in the last decade, not to mention the sizable upward pressure it would place on the US dollar. Even at current levels, the dollar will represent a renewed drag on US multinational earnings in the first quarter (see Exhibit 60).

Exhibit 60: US Dollar Index
Even if the dollar stays unchanged, it will still act as a drag on US multinational earnings in early 2017.

Data through December 31, 2016, with illustrative projection through 2017.
Source: Investment Strategy Group, Bloomberg.

That said, the collective impact of these various risks is not yet sizable enough to undermine our core view: we are in a longer-than-normal US recovery that supports equity returns that are

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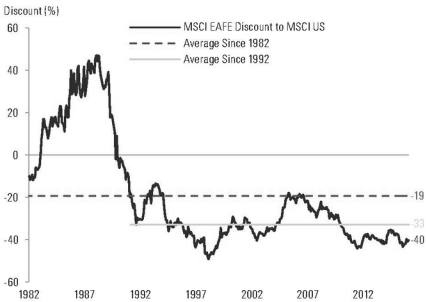
Exhibit 61: EAFE Price to 10-Year Average Cash Flow Discount to the US

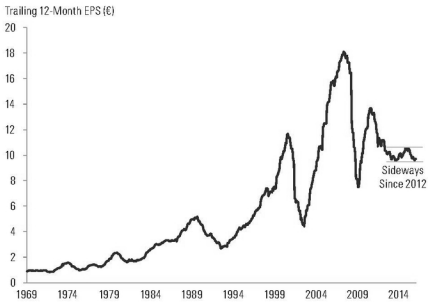
Today's larger-than-average discount provides a margin of safety to EAFE equities.



Data through December 31, 2016.
Source: Investment Strategy Group, MSCI, Datastream.

Exhibit 62: MSCI EMU Trailing 12-Month Earnings per Share

Profits have been range-bound for almost four years.



Data through December 31, 2016.
Source: Investment Strategy Group, Bloomberg.

likely to exceed those of cash and bonds. In turn, we recommend that clients maintain their strategic weight in US equities, although we acknowledge that risks have risen at the same time that returns appear likely to be lower going forward. While US equities are not yet running on fumes, we should keep a close eye on the fuel gauge.

EAFE Equities: Priced for Imperfection

There is no shortage of concerns surrounding the various countries that comprise Europe, Australasia and the Far East (EAFE) equity markets. The list is both long and valid, including persistently low economic growth, a slow pace of structural reforms and incessant political uncertainty, as well as incremental, reactive and inconsistent policy responses. Ongoing questions about the health of the banking system only compound these worries.

But these concerns are also not new and are consequently well understood by the market. In turn, the key question facing investors is not whether EAFE exposure subjects them to downside risks. As the preceding list demonstrates, it clearly does. The question instead is whether investors are being fairly compensated to bear these risks.

One can never know precisely what equity markets are discounting, but the above concerns are almost certainly a key driver of EAFE underperformance and the main reason behind today's larger-than-normal valuation discount to US equities (see Exhibit 61). While this margin of safety does not guarantee outperformance, it may provide investors with a larger buffer to absorb adverse developments and miscalculations in their forecasts. In our view, the risk/return profile of EAFE equities is more attractive than it first appears.

As a result, we do not recommend that investors underweight EAFE equities. In fact, there are reasons to believe that EAFE equities will outperform US equities in local currency terms this year. In the sections that follow, we explore these reasons by examining the three main EAFE markets, beginning with the Eurozone.

Eurozone Equities: The Onus Is on Earnings

Earnings have been going nowhere fast for Eurozone equities. That's apparent in Exhibit 62, which shows that profits have been range-bound—at nearly half their 2007 peak level—for almost four years. As a result, rising valuation multiples have accounted for all of the 25% price appreciation over this period.

This seeming contradiction between stagnant earnings and rising multiples reflects the copious liquidity provided by the ECB's quantitative easing. By depressing interest rates, ECB policy

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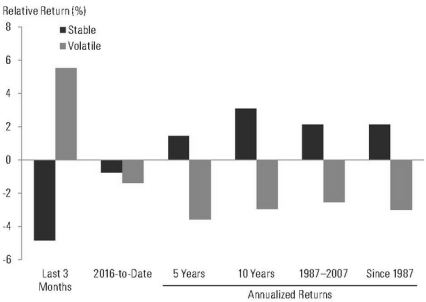
Exhibit 63: Relative Performance of "Stable" and "Volatile" EAFE Stocks

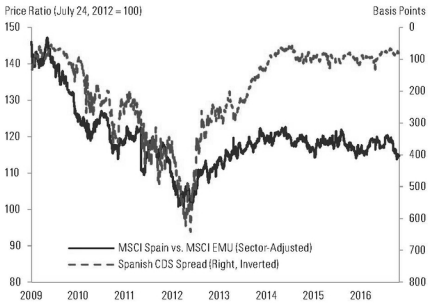
Investors have recently shifted toward firms more exposed to the business cycle.



Data as of October 31, 2016.
Note: Equally weighted USD-hedged returns relative to the developed markets (ex-US). Stable and volatile stocks are drawn from the large-cap universe. Stability is measured using a model based on return on equity, earnings growth, financial leverage and beta.
Source: Investment Strategy Group, Empirical Research Partners.

Exhibit 64: Spain 5-Year Credit Default Swap and Relative Equity Performance

The dramatic reduction in Spanish default risks suggests equity valuations have scope for upside.



Data through December 31, 2016.
Source: Investment Strategy Group, MSCI, Datastream.

has both hobbled bank profits—which represent a third of EuroStoxx 50 earnings—and boosted equity valuations. But with ECB policy unlikely to become any more accommodative, additional valuation expansion can no longer be taken for granted. Instead, the onus for Eurozone equity upside now rests with earnings.

Here, the prospects are favorable for several reasons. First, above-trend Eurozone GDP growth is likely to lead to boosted domestic sales and reduced economic slack, both of which have lifted Eurozone earnings in the past. Second, the broader pickup in global GDP growth we expect should benefit the 45% of the EuroStoxx 50's sales that are generated outside Europe. Higher revenue is particularly beneficial to these EuroStoxx firms given their operating leverage, as small improvements in sales spread over their sizable fixed costs also push profit margins higher. Finally, financial sector earnings stand to benefit from the higher interest rates we foresee.

Against this backdrop, we expect earnings to expand 5% in 2017. Meanwhile, valuation multiples are likely to contract slightly as interest rates normalize higher and investor focus shifts toward eventual ECB tapering late this year. Combining these elements with a 3.6% dividend yield implies EuroStoxx 50 total returns of 3% in 2017.

The risks to our base case are skewed mildly to the upside. After underperforming most equity markets in 2016, Eurozone equities have room to play catch-up. Moreover, the passing of long-feared French and German elections could compress today's elevated equity risk premium, although political uncertainty is likely to remain high in the interim. Finally, investors' recent shift toward firms more exposed to the business cycle should benefit Eurozone firms given their greater operating leverage (see Exhibit 63).

Within the Eurozone, we are overweight Spanish equities. Here, we are drawn to attractive valuations (see Exhibit 64), domestic growth momentum and embedded overweight to banks.

UK Equities: Scaling the Wall of Worry

While the Brexit vote was surprising, the subsequent performance of the UK stock market was even more so. Despite the tremendous political and social uncertainty engendered by the referendum's outcome, UK equities generated one of the strongest returns of any major equity market last year in local currency terms.

Several factors at the root of this outperformance should continue to work in favor of UK equities in 2017. First, FTSE 100's global

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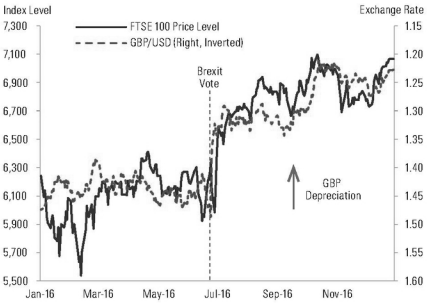
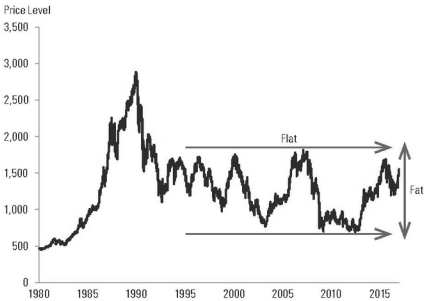
Exhibit 65: FTSE 100 Price Level and British Pound
A weaker pound benefits FTSE 100 companies, which generate 75% of sales outside the UK.



Data through December 31, 2016.
Source: Investment Strategy Group, Bloomberg.

Exhibit 66: TOPIX Price Level
Japanese equities have traded in a large-but-contained range.



Data through December 31, 2016.
Source: Investment Strategy Group, Goldman Sachs Global Investment Research, Bloomberg.

footprint—75% of sales come from outside the UK economy—should benefit from the accelerating global GDP growth we expect this year, just as this exposure profited from last year's 16% depreciation of the British pound (see Exhibit 65). Second, last year's best-performing sectors—commodities and financials—are well positioned to extend their run. Financials—the largest UK sector—stands to benefit from rising interest rates, while the commodity sectors should get a boost from higher oil prices. Notably, these two sectors account for nearly half of FTSE 100 market capitalization.

With these tailwinds in mind, we forecast UK earnings growth of 11% this year, the highest of our estimates across EAFE markets. That said, continued uncertainty around the implications of Brexit coupled with higher interest rates will likely weigh on FTSE 100's well-above-average valuations. This view, combined with the UK equity market's hefty dividend yield of 4.0%, results in a 4% total return projection for the FTSE 100.

Although this return is attractive on its face, we do not believe it offers investors a large enough margin of safety to justify a tactical overweight. Keep in mind that significant uncertainties remain around the final contours of Brexit. Moreover, a shift by the Bank of England toward raising interest rates this year could reverse much of the British pound's depreciation, to the detriment of UK earnings. Finally, FTSE 100's global footprint could magnify any disruption to global trade volumes resulting from protectionist policies.

We project UK earnings growth of 11% this year, the highest of our estimates across EAFE markets.

Japanese Equities: Scaling a Familiar Peak

Japanese equities have experienced their fair share of booms and busts over the last 25 years. As seen in Exhibit 66, this pattern of offsetting swings has resulted in a "fat and flat"[108] trading range. With the TOPIX price level again in the upper third of its historical band, it is natural to ask whether 2017 will mark yet another market top in Japan.

The earnings outlook is pivotal to answering this question. While our forecast for accelerating global GDP growth points toward higher earnings, near-peak profit margins are a headwind (see Exhibit 67). Moreover, with less central bank easing given the BOJ's already sizable balance sheet, yen depreciation—a key driver of Japanese revenue growth since 2012—is expected to moderate this year. Even so, the

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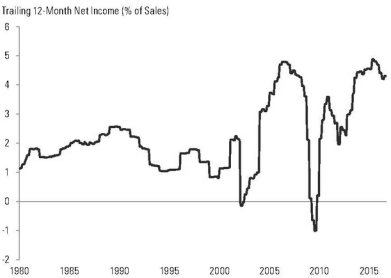
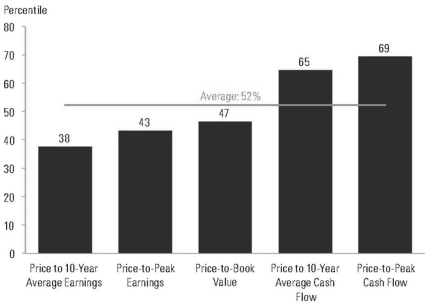
Exhibit 67: Japanese Profit Margins
Near-peak profit margins could be a headwind for Japanese equities.



Data through November 30, 2016.
Source: Investment Strategy Group, Datastream.

Exhibit 68: Japanese Equity Valuations
Valuations are near the median level of Japan's deflationary period since 1999.



Data as of December 31, 2016.
Note: Based on data since 1999.
Source: Investment Strategy Group, Datastream, MSCI.

interplay of these inputs should still lead to positive earnings growth of 6% in 2017.

The direction of valuation multiples is equally important. As shown in Exhibit 68, Japanese valuations are middling based on their history since 1999, which we believe is the relevant evaluation period given the deflationary headwinds that emerged thereafter. For equity multiples to move significantly higher from here would require sustainable above-trend earnings growth or a sizable increase in direct equity purchases by the Japanese central bank. But with the BOJ already holding a remarkable 60% of Japanese ETF market assets[109] and profit margins near their peak levels, neither of these upside catalysts seems probable. In fact, P/E multiples are forecast to contract in our base case, as the 6% earnings growth we expect will likely disappoint current market expectations of 12%.

Putting these pieces together, we expect neither a boom nor a bust for Japanese equities. Instead, the combination of mid-single-digit earnings growth, slight compression in valuation multiples and a 1.9% dividend yield should generate a 5% total return. While this return is attractive from an absolute standpoint, it also comes with significant downside risks given the country's poor demographics, declining labor force and high government debt load. Consequently, we are tactically neutral on Japanese equities currently.

Emerging Market Equities: Finally in Gear, but Potholes Ahead

Emerging market equities as a whole finally moved forward in 2016 after three years in reverse: multiples expanded, earnings estimates improved and currencies appreciated, generating a 12% total return. Politics and commodity prices were key performance differentiators among emerging markets last year, leading Brazil and Russia to the winners' podium while leaving Turkey and Mexico in last place.

We expect emerging market equities to remain on track in 2017. Our central case calls for earnings growth of 5% in US dollar terms, driven by faster nominal GDP growth and the lagged impact of easier financial conditions and higher commodity prices. But with multiples already at post-crisis highs in an environment of rising global rates and heightened risks, we see little scope for further expansion. Combining these two inputs with a dividend yield of 2.6%, our forecast implies a total return of about 7% this year.

However, the uncertainty around this forecast is quite large, as emerging market equities face several potential potholes on the road ahead. Chief among these is the ultimate policy agenda of the incoming US administration. On the one hand, a policy mix that favors US growth over trade restrictions would support emerging market exports and boost profits and equity returns.

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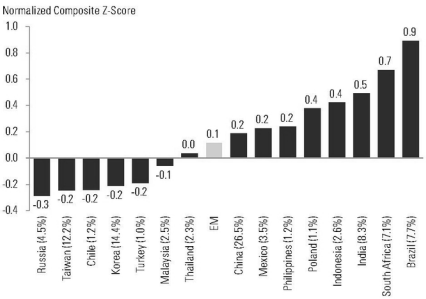
Exhibit 69: EM Equity Valuations

Aggregate valuations are near neutral levels.



Data as of December 31, 2016.
Note: Based on monthly data since 1994 for Price/Forward Earnings, Price/Book Value, Price/Cash Flow, Price/Sales, Price/Earnings-to-Growth Ratio, Dividend Yield and Return on Equity. Numbers in parentheses denote the country's weight in MSCI EM. Only showing countries with a weight greater than 1%.
Source: Investment Strategy Group, Datastream, I/B/E/S, MSCI.

On the other hand, a harsher US stance on trade and foreign policy would hurt emerging market earnings, sentiment and valuation multiples. China, Korea, Mexico and Taiwan—which account for about 60% of MSCI emerging market capitalization and earnings—seem particularly vulnerable in the latter scenario. In comparison, countries with less exposure to the US economy and already strong domestic demand, such as India and Indonesia, would likely fare better.

Against this uncertain backdrop and considering today's uninspiring valuations (see Exhibit 69), we remain tactically neutral on emerging market equities. That said, we continue to explore relative investment opportunities that exploit the significant domestic activity, external vulnerability and valuation differences among individual emerging countries.

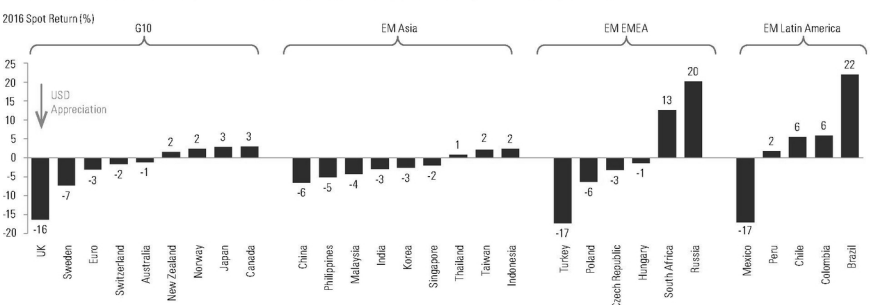
2017 Global Currency Outlook

In a notable departure from recent years, the US dollar did not enjoy unequivocal dominance in 2016 (see Exhibit 70). The yen, for example, ended a four-year slide against the greenback as the market questioned the BOJ's commitment to monetary easing. Certain emerging market currencies—such as the Russian ruble and Brazilian real—also outperformed the dollar on the back of stronger commodity prices and favorable political developments at home. And while the dollar did make notable gains against the euro, pound and Mexican peso in particular, these currencies enter 2017 with a more balanced risk/reward profile as a result.

The upshot is that while tightening monetary policy and potential fiscal expansion in the US will continue to favor dollar strength, those gains are likely to be more modest and reflected in a narrower set of currencies as the dollar bull market enters its fifth year. Our tactical positioning

Exhibit 70: 2016 Currency Moves (vs. US Dollar)

For the first time in several years, the US dollar did not appreciate against all major currencies.



Data as of December 31, 2016.
Source: Investment Strategy Group, Bloomberg.

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incorporates this view, as we are neutral on the euro, yen and pound versus the US dollar, but remain bearish on the Chinese renminbi.

We discuss our view on the broader US dollar, as well as each of these currencies, next.

US Dollar

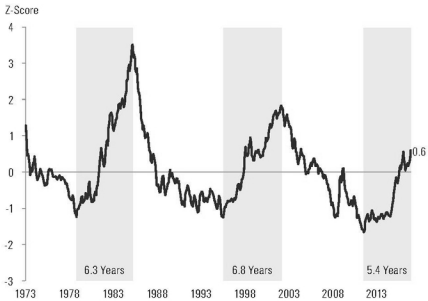
Following three consecutive years of dollar outperformance, it would be reasonable to assume the up-cycle is nearing an end. After all, dollar valuation is now close to its historic average level relative to the currencies of US trade partners, after adjusting for inflation. Moreover, the length of this dollar bull market is approaching that of the two prior episodes shown in Exhibit 71 and shares a similar underlying driver—tighter monetary policy in the US relative to its global peer group.

But while we expect the pace of US dollar appreciation to slow, there are many reasons to believe the greenback's outperformance can continue this year. Dollar valuation remains below the peaks reached in the 1985 and 2002 bull cycles, suggesting it is not yet prohibitively expensive. The dollar should also benefit from solid US macroeconomic fundamentals relative to other developed economies. President-elect Trump ran on a platform that includes fiscal expansion and corporate tax reform. Although his economic team's spending plan is still forthcoming, the package could represent an economic tailwind that may justify tighter US monetary conditions at a time when foreign central banks have committed to easier policy. In turn, relatively higher US yields may entice global investors to favor US dollar assets over lower-yielding foreign-denominated alternatives.

Furthermore, some elements of the new administration's desired corporate tax reform could present material upside risk to the US dollar. For example, the destination-based tax system supported by several House Republicans disallows deductions for any imported good or service—

Exhibit 71: US Dollar Real Effective Exchange Rate

Dollar valuations are near their long-term average but below levels reached in past bull cycles.



Data through November 30, 2016.
Note: Z-score is calculated on data since 1973 and represents the number of standard deviations from the mean. Shaded areas highlight periods of dollar strength.
Source: Investment Strategy Group, Datastream.

effectively supporting US goods by making them more competitive. Economic theory suggests that free-floating currencies such as the US dollar would need to adjust higher by the amount of the tax to create equilibrium with similar goods sourced across foreign borders. Taken at face value, this implies a 20% destination tax would require a simultaneous—and potentially very disruptive—20% increase in the US dollar. A tax holiday for cash held abroad could be similarly dollar positive, in spirit if not in magnitude. While it is true that a majority of the $2.6 trillion of US corporate earnings trapped overseas are already held in US dollar assets, the greenback would still enjoy a tailwind if corporates elected to repatriate some portion of the foreign currency balance.

That said, the risks to the US dollar are not exclusively to the upside, as much of the good news is embedded in current prices (see Exhibit 72). Consider that the bulk of last year's dollar advance occurred in the two weeks following the US presidential election in November, as the market quickly discounted a portion of potential policy changes. Moreover, Federal Reserve rate hike expectations for 2017 have increased following stronger US activity data during the second half of 2016. Lastly, we expect the BOJ and ECB to maintain their highly accommodative policies again this year. With these tailwinds already

Dollar gains are likely to be more modest and reflected in a narrower set of currencies as the dollar bull market enters its fifth year.

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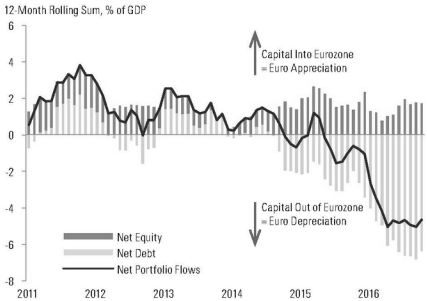
Exhibit 72: Trade-Weighted US Dollar Index
The recent dollar rally implies much of the good news has already been priced in.

Data through December 31, 2016.
Note: Shaded areas denote periods of US recession.
Source: Investment Strategy Group, Datastream.

Exhibit 73: Eurozone Net Portfolio Flows
Policy divergences could continue to drive portfolio investment out of the Eurozone.



Data through October 31, 2016.
Note: Q3 2016 data used to calculate Q4 2016 share of GDP.
Source: Investment Strategy Group, Haver Analytics.

partly reflected in current exchange rates, the US dollar is vulnerable to both domestic and foreign disappointments.

In sum, we expect the dollar to appreciate further, but at a slower pace and with greater volatility than in recent years.

Euro

The euro was on the losing side of the US dollar's strength again in 2016, marking the third consecutive year of underperformance and the longest stretch of annual declines since 2001. Last year's modest 3.2% decline actually masked a much larger 10% drop from the euro's intra-year peak, half of which came in the weeks following the US elections in November. Needless to say, the combination of potentially expansionary fiscal policy put in place by the new administration coupled with tighter US monetary policy represents a stiff headwind to the euro, particularly since the ECB just extended quantitative easing until December 2017.

We expect these transatlantic policy divergences to persist, driving European investors to continue seeking higher-yielding, non-euro-denominated assets abroad (see Exhibit 73). This preference will likely be bolstered by uncertainty surrounding upcoming national elections in Germany, France, the Netherlands and possibly Italy and Spain. While our central case assumes mainstream parties prevail, any result that raises questions about the long-term viability of the European Monetary Union could push the euro even lower.

Still, we should not lose sight of the fact that after such persistent weakness versus the US dollar, the euro is undervalued and investors are now positioned for further weakness. Additionally, the above-trend Eurozone growth and normalizing inflation we expect could justify the ECB shifting toward a more neutral stance later this year. Such a move would narrow the interest rate differential between the US and Eurozone, weakening a linchpin of the weaker euro thesis.

Given this balance of risks, we removed our tactical short positions in the euro relative to the dollar following the November US presidential election, returning to a neutral view.

We should not lose sight of the fact that after such persistent weakness versus the US dollar, the euro is undervalued and investors are now positioned for further weakness.

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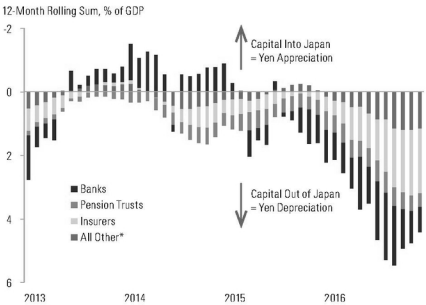
Exhibit 74: Japanese Net Purchases of Foreign Long-Term Debt by Investor Type

Additional buying of foreign assets by Japanese investors could put further downward pressure on the yen.



Data through November 30, 2016.
Note: Q3 2016 data used to calculate Q4 2016 share of GDP.
Source: Investment Strategy Group, Haver Analytics.
* All Other defined as central banks, general government, financial instruments firms, investment trust management companies and others.

Yen

For yen investors, last year was a reminder that markets often take an escalator up but an elevator down. After steadily appreciating almost 20% against the US dollar over the first nine months of 2016, the currency forfeited those gains in just weeks after the surprising US presidential election. Although the net effect was a small 2.8% appreciation last year—breaking a four-year streak of yen weakness—we do not believe further yen strength is likely.

There are two reasons for this view. First, the BOJ will likely keep rates negative or close to zero this year by maintaining highly accommodative monetary policy. In turn, Japanese investors will continue to sell low-yielding domestic assets—placing downward pressure on the yen—in order to fund purchases of higher-yielding offshore assets (see Exhibit 74). Japan's Government Pension Investment Fund (GPIF)—which manages the world's largest public pension—is a case in point, as it will need to sell domestic fixed income assets to reach its stated targets for foreign investments. Similarly, Japanese life insurers may increase their exposure to foreign currencies if interest rate differentials between the US and Japan remain wide.

Second, Japanese corporations are likely to sell yen to invest in foreign operations with better growth prospects, which will also place downward pressure on the Japanese currency; such announcements are already on the rise.[110]

This is not to suggest that the prospects for the yen are completely one-sided. The higher global rates we expect may make it difficult for the BOJ to maintain such low domestic yields, which would alleviate some of the downward pressure on the currency. Moreover, the many sources of global uncertainty in the year ahead could lead investors back into the yen as a liquid hedge, as we saw in the first half of 2016. Finally, after four years of weakness, the yen has reached undervalued levels.

Given this more balanced risk profile, we currently have no tactical position in the yen.

British Pound

While broader financial markets were unperturbed by the UK's decision to leave the European Union, the same cannot be said for currencies. Here, the Brexit vote sent the pound tumbling to its lowest level versus the US dollar since the 1985 Plaza Accord.[111] Although the pound has since recovered some of those losses, its 16.3% decline relative to the US dollar last year still ranks as the worst performance among all developed market currencies.

The trajectory of the pound will be largely shaped by the evolution of Brexit negotiations. Even though six months have passed since the vote, there is no greater clarity on how the UK will ultimately exit the European Union and on what terms. Clearly a combative stance could see the pound weaken further as the market discounts lower potential growth in the UK. Alternatively, a more conciliatory negotiating position could lead to upside from today's depressed levels.

Barring a hostile negotiating tack from the UK government, the pound also has several other factors working in its favor. First, foreigners continue to buy pounds to invest in UK-domiciled assets and firms, which is vital to funding the UK's sizable 5.2% of GDP current account deficit. In fact, one of the largest cross-border acquisitions last year was announced less than one month following the EU referendum.[112] Importantly, higher-frequency data shows this merger and acquisition (M&A) momentum is continuing (see Exhibit 75).

Second, the Bank of England may need to raise interest rates sooner than markets now expect, as erstwhile sterling depreciation is quickly feeding

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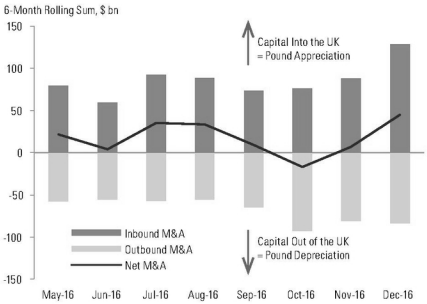
Exhibit 75: UK Cash Merger and Acquisition Announcement Pipeline

Continued inbound M&A activity could benefit the pound.



Data through December 31, 2016.
Note: October 2016 outbound M&A adjusted to exclude stock portion of British American Tobacco's takeover of Reynolds.
Source: Investment Strategy Group, Bloomberg.

through to higher domestic inflation. In turn, higher UK interest rates would make sterling-denominated assets more appealing to foreign investors and support the currency.

Finally, while sterling certainly has scope to depreciate, market participants are already well-positioned for further weakness. Those positions may become vulnerable if the UK's negotiations with its trade partners turn more amicable and the domestic UK economy remains resilient.

With these upside risks being tempered by the unknowable evolution of Brexit negotiations for now, we see balanced risks for the pound this year and thus remain tactically neutral.

Emerging Market Currencies

Emerging market currencies caught a welcome updraft last year, following a 45% freefall since mid-2011. The flight was not without turbulence, however. Following a 12% rally in the first half of the year—reflecting a dovish shift in US monetary policy and waning fears about Chinese capital outflows—emerging market currencies hit an air pocket that erased much of these gains following the surprise outcome of the US elections.

We believe this downdraft is likely to persist. The prospect of higher US interest rates, a stronger dollar and China's bumpy deceleration spells tighter global financial conditions and a risk of capital outflows from emerging markets—conditions that have historically constituted a stiff headwind to their currencies.

These risks are magnified by the uncertainty surrounding the incoming US administration's trade policies. Fears of protectionism have already negatively impacted the currencies of China and Mexico—the two largest sources of manufacturing exports to the US—with the peso and Chinese renminbi down 11.6% and 2.3%, respectively, since the election.

Even so, we do not think a broad tactical short in emerging market currencies is appealing at this stage. Despite the small rally last year, emerging market currencies remain attractively valued (see Exhibit 76), particularly given their enticing 5% yield differential to the US dollar. Moreover, the new US administration may prove to be more measured in its actions than its rhetoric—a non-negligible risk that could revive sentiment and improve prospects for emerging market currencies. The Mexican peso, in particular, could benefit in that event.

For now, we remain tactically positioned to benefit from further renminbi weakness given our long-standing concerns about China's economic vulnerabilities and the likelihood of looser policy, policy mistakes and capital outflows. The potential for US trade protectionism directed at China, though not our base case, would further benefit this position.

2017 Global Fixed Income Outlook

Last year witnessed a notable reversal of fortune for global interest rates. Despite reaching all-time closing lows shortly after the surprise Brexit vote, 10-year yields in developed markets had reclaimed much—if not all—of those declines by year-end. In the US, a more than one percentage point swing was sufficient to turn the 10-year bond's 9% gain into a loss.

While some have portrayed this reversal as just another setback in the now three-decade-old bond bull market, we are more skeptical. The policy mix that has depressed interest rates in the post-crisis period—a combination of fiscal austerity, negative or near-zero central bank policy rates and large-scale asset purchases—is losing favor, as even policymakers acknowledge the often counterproductive impact of these policies. At

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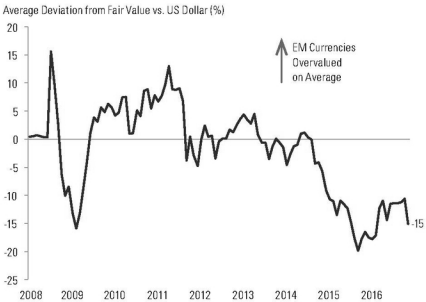
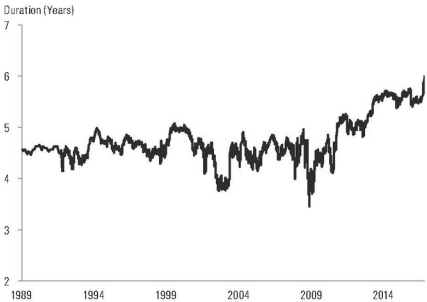
Exhibit 76: Emerging Market Currency Valuation
Despite the recent rally, emerging market currencies remain undervalued against the US dollar.



Data through November 30, 2016.
Note: Average of Goldman Sachs Dynamic Equilibrium Exchange Rate, 5-year moving average, and Fundamental Equilibrium Exchange Rate misalignments of currencies in the JP Morgan Government Bond Index—Emerging Markets Global Diversified.
Source: Investment Strategy Group, Bloomberg, Datastream, Goldman Sachs Global Investment Research, Peterson Institute for International Economics.

Exhibit 77: Estimated Duration of US Bond Market
The bond market's sensitivity to rising rates is the highest on record.



Data through December 31, 2016.
Note: Based on the Barclays US Aggregate Bond Index.
Source: Investment Strategy Group, Bloomberg.

the same time, the recovery in commodity prices, recent firming in global growth and potential for expansionary fiscal policy are shifting the focus from deflation to reflation.

This shift in perspective arrives at a time when the market's vulnerability to rising rates is the highest on record (see Exhibit 77). Losses from these long-duration positions in response to higher rates could beget more bond sales, creating a vicious cycle. That yields are still extremely low by historical standards does little to assuage these fears. Consider that 10-year government bond yields in all G-7 countries have been higher at least 90% of the time since 1958. Given all the above, we believe the ascent of interest rates remains in its infancy.

Still, it is important to differentiate between a normalization of interest rates and a disorderly backup. While we expect higher interest rates over the coming years, secular headwinds—like aging demographics and slower productivity growth—suggest the terminal point of that increase will be lower than the historical average. This fact is not lost on the Federal Reserve, which has reduced its estimate of the long-run equilibrium nominal rate—the rate consistent with full employment and stable inflation in the medium term—from 4.25% to 3% over recent years.

For now, we remain tactically positioned to benefit from further renminbi weakness given our long-standing concerns about China's economic vulnerabilities and the likelihood of looser policy, policy mistakes and capital outflows.

With a lower interest rate target to reach, the Federal Reserve is likely to proceed slowly, particularly given uncertainty around its estimate of the economy's equilibrium rate and lingering international risks. Even if the Federal Reserve were to raise rates three times in 2017, that pace would still be less than half of the historical median tightening pace.[113] Thus far in this cycle, the Federal Reserve has raised rates only once per year.

Against this backdrop, we recommend investors favor credit over duration risk

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by remaining overweight US corporate high yield credit versus investment grade fixed income and by funding various tactical tilts from their high-quality bond allocation. While most investment grade bonds may have uninspiring tactical prospects, we emphasize that investors should not completely abandon their bond allocation in search of higher yields. As the last several years have reminded us, investment grade fixed income serves a vital strategic role in the portfolio, due to its ability to hedge against deflation, reduce portfolio volatility and generate income.

In the sections that follow, we review the specifics of each fixed income market.

US Treasuries

While 2016 began as a bumper year for US Treasuries, it ended in a rout. The yield on 10-year Treasury bonds, for example, reached an all-time low of just 1.36% by the middle of last year before jolting higher by more than one percentage point by year-end. As a result, investors' nearly double-digit gains devolved into a small loss. Even worse, the bulk of the rate increase occurred in just the last three months of 2016, generating a 7% loss for the quarter that has been exceeded less than 1% of the time historically since 1981.

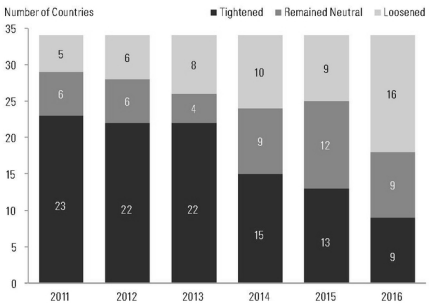
We expect rates to continue to increase, albeit at a slower pace in 2017, as many of the forces that have restrained yields are slowly fading. Inflation, in particular, has been a persistent drag, reflecting a toxic combination of excess labor slack that depressed wages, a strong dollar that lowered import prices and a significant decline in oil prices that weighed on breakeven inflation rates. But as we begin the eighth year of the US expansion, labor slack has been largely absorbed, evident in today's firming wages. Moreover, the impact of the dollar is diminishing as its pace of ascent slows, while the recovery in oil is boosting breakeven inflation rates.

Other headwinds are also receding. The fiscal austerity among the advanced economies that has dampened economic growth and decreased sovereign bond issuance—both of which depress interest rates—is now reversing (see Exhibit 78). Indeed, US fiscal spending is expected to add 0.3–0.5 percentage points to GDP growth in each of the next two years.[114]

At the same time, there is reduced demand for risk-free assets, like US Treasuries, given the unexpectedly sanguine reaction to negative

Exhibit 78: Fiscal Stance of Advanced Economies

Fiscal austerity in developed markets has reversed in recent years.



Data as of December 31, 2016.
Source: Investment Strategy Group, IMF.

geopolitical events—such as the UK and Italian referenda—and the results of the US election. Finally, the deleterious impact of depressed interest rates on banking sector profitability has raised the hurdle for global central banks to cut interest rates further and/or increase the scale of QE programs. In turn, market focus has shifted toward the eventual tapering of BOJ, ECB and BOE accommodation, which has helped lift bond term premiums and boosted long-term yields (see Exhibit 79).

In light of these waning headwinds, the Federal Reserve is likely to hike two or three times in 2017, with upside risks from a larger-than-anticipated fiscal expansion. Combined with some further normalization in the term premium, we expect 10-year rates to increase to 2.50–3.00% by year-end. Given the balance of risks, we remain comfortable funding tactical tilts out of investment grade fixed income.

Treasury Inflation-Protected Securities (TIPS)

TIPS fared better than nominal bonds in 2016, delivering a positive mid-single-digit return. Their outperformance was driven by the recovery in breakeven inflation rates, which began the year at very depressed levels consistent with only 1.5% annual inflation over the next 10 years—well below long-run forecasts (see Exhibit 80). In fact, our work suggests that breakeven inflation rates were reflecting high odds of a deep recession over the course of 2016, well above the risk suggested by our recession models.

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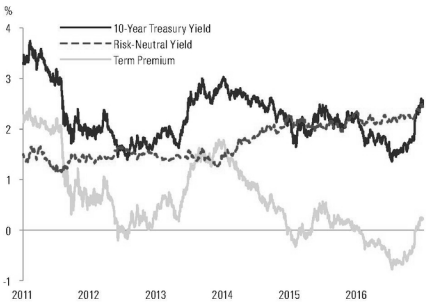
Exhibit 79: US 10-Year Yields and Term Premium
Expected tapering from major central banks has contributed to higher long-term yields and bond term premiums.



Data through December 31, 2016.
Source: Investment Strategy Group, Bloomberg.

Exhibit 80: US 10-Year Breakeven Inflation Rate and Consensus Inflation Rate Forecasts
TIPS benefited from a recovery in breakeven inflation rates in 2016.

Data through December 31, 2016.
Source: Investment Strategy Group, Bloomberg.

We think that breakeven inflation rates have further room to rise as the concerns that depressed them last year fade. First, oil prices are recovering, reversing the persistent drag they had exerted throughout much of early 2016. Second, wages are firming and fiscal policy is being eased, dampening deflation worries. Finally, recession odds are falling as the drag from oil weakness and dollar strength fades.

With breakeven inflation rates still below long-term consensus forecasts and the Federal Reserve's target, we expect positive total returns from TIPS in 2017. Still, TIPS' absolute returns are likely to be modest, as their eight-year duration will make it difficult for coupon income to meaningfully exceed principal losses as rates rise. Moreover, given TIPS' unfavorable tax treatment (discussed at length in our 2011 *Outlook*), we continue to advise US clients with taxable accounts to use municipal bonds for their strategic allocation.

We expect rates to continue to increase, albeit at a slower pace in 2017, as many of the forces that have restrained yields are slowly fading.

US Municipal Bond Market

Municipal bond holders were not immune from 2016's about-face in US Treasury yields. Last October, municipal bonds were enjoying some of their best returns in years, only to be hit by losses arising from both rising interest rates and budding concerns about tax changes in the wake of the US presidential election. The abrupt redemptions of municipal bond mutual funds only exacerbated these losses, with the pace of outflows second only to the mid-2013 taper tantrum (see Exhibit 81). All told, municipal bonds suffered one of their worst years in recent history, with intermediate municipal bonds actually experiencing a rare loss (see Exhibit 82).

Unfortunately, the near-term outlook remains challenging. As Exhibit 81 reminds us, mutual fund flows tend to be sticky in this asset class, with persistent periods of both buying and selling depending on the trajectory of interest rates. Based on historical episodes, there is scope for the current string of outflows to extend further.

Moreover, clarity on tax policy will remain elusive for months, during which time headline risk will be significant. Even worse, a sizable reduction in the top individual tax rate for municipal bonds—if ultimately passed—could significantly shift the economics of owning them, leading to further sales. These fresh worries on tax policies

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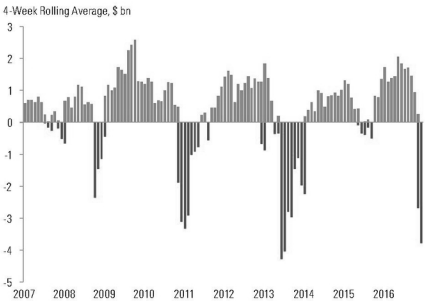
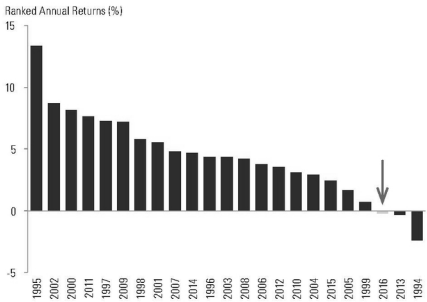
Exhibit 81: Municipal Bond Mutual Fund Flows
The pace of outflows at the end of 2016 was surpassed in recent history only by the 2013 taper tantrum.



Data through December 31, 2016.
Source: Investment Strategy Group, ICI.

Exhibit 82: Annual Municipal Bond Returns Since 1994
Intermediate municipal bonds experienced a rare loss in 2016.



Data as of December 31, 2016.
Source: Investment Strategy Group, Barclays.

only add to existing concerns about pension funding levels.

While there is clearly no shortage of risks, the silver lining to last year's rout is that we begin 2017 with a much larger valuation buffer to help absorb them. As seen in Exhibit 83, the ratio of municipal yields to Treasury yields is above average for both 5- and 10-year maturities. In turn, investors can currently earn an extra 70 basis points of after-tax yield by owning five-year municipal bonds instead of same-maturity Treasuries—a yield pickup more than double the post-crisis median of 31 basis points. Moreover, this incremental after-tax yield would still be around 50 basis points if the top individual tax on investment income were reduced by 10 percentage points—from 43.4% with the Affordable Care Act (ACA) tax to 33% under new policy recommendations. In short, municipal spreads currently offer a potential offset to rising rates and potential tax changes.

Also keep in mind that municipal fundamentals remain stable. Major state and local tax revenues have continued to increase at a moderate 3% pace, which should be supported by the above-trend US economic growth and rising home prices we forecast. Meanwhile, governments have exercised restraint on capital spending. Consider that net issuance expectations of $30 billion for 2017 stand well below the pre-crisis 10-year annual average of $110 billion.[115] This restraint has not only kept net supply low—as new issuance has been largely offset by maturing debt—but has also helped municipal finances. Ratings trends have improved as a result of both stable revenue and spending discipline, with upgrades in the Moody's universe seeing a notable uptick in last year's third quarter (see Exhibit 84).

Of course, underfunded long-term pension liabilities remain a source of concern. But with aggregate funding levels holding steady at around 74%, we do not think this will be a primary focus in 2017, particularly given last year's increase in stock prices. While rising equity values will do little to remedy municipals' inadequate funding contributions, they will help increase the value of pension assets. Moreover, these medium-term concerns are not the primary driver of recent municipal bond weakness. After all, today's funding levels are no worse than they were in October of last year, a time when municipal bonds were enjoying some of their best returns ever.

All told, we expect intermediate municipal strategies to gain about 1% in 2017. With this return close to that of cash but with more downside potential, we still think it makes sense for clients to fund various tactical tilts from their high-quality municipal bond allocation. This recommendation is motivated primarily by rate risk and not credit concerns, since we expect municipal defaults to be rare events. Outside tilt funding, we recommend clients target their

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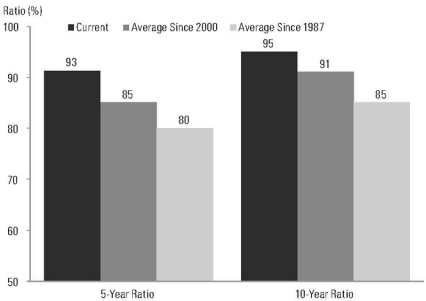
Exhibit 83: Ratio of Municipal Bond Yields to Treasury Yields

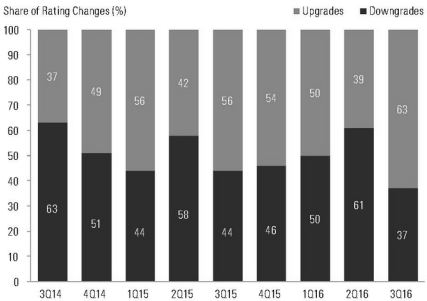
Current municipal bond yields offer a larger valuation buffer to absorb risks than in the past.



Data as of December 31, 2016.
Source: Investment Strategy Group, Bloomberg, Thomson MMD.

Exhibit 84: Municipal Issuer Rating Changes

Stable revenue and spending discipline have led to recent issuer rating upgrades.



Data as of Q3 2016.
Source: Investment Strategy Group, Moody's.

benchmark duration. Given their important portfolio hedging characteristics, municipal bonds should remain the bedrock of the "sleep-well" portion of a US-based client's portfolio.

The same can be said for high yield municipal bonds. Despite their almost 10-year duration, these bonds currently offer attractive spreads of close to 3%, a level that has been higher only 29% of the time since 2000. This spread provides a substantial buffer that could partially offset higher Treasury yields, enabling the high yield municipal market to deliver positive returns of around 4% in our base case. Therefore, we recommend clients stay invested at their customized strategic weight.

US Corporate High Yield Credit

Even for the bullish among us, last year's 17% total return in corporate high yield was surprisingly strong. Not only was it the largest gain within US fixed income, but it also ranked among the top annual returns of all time for the asset class. What makes this performance even more impressive is that high yield was down about 5% at its worst point in early 2016.

But these sizable gains have come at a cost. Spreads—which compensate investors for the risk of default losses—now stand well below their long-term average. In fact, the level of spreads has been lower only a third of the time in the last 30 years. Moreover, yields have fallen from above 10% early last year to less than 7% now, diminishing the allure of these bonds to investors searching for high returns.

Even so, we think the strong fundamentals underpinning the asset class still warrant an overweight, though returns are almost certain to be more modest going forward. At the heart of this stance is our benign view on default losses, which are the primary risk to high yield investors. Here, several factors support our below-historical-average 2.5% par-weighted default forecast for 2017.

First, high yield firms stand to benefit directly from the strengthening US economy we expect this year, considering almost three-quarters of their sales originate domestically.[116] Second, leading indicators of defaults—such as Moody's liquidity and covenant stress indexes—are trending downward, suggesting fewer speculative-grade companies are

While there is clearly no shortage of risks, the silver lining to last year's rout in municipal bonds is that we begin 2017 with a much larger valuation buffer to help absorb them.

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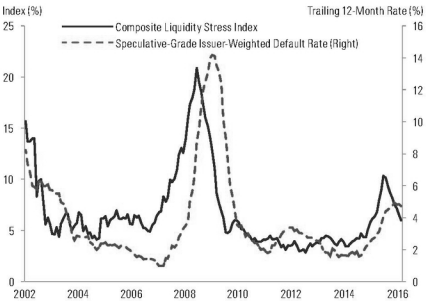
Exhibit 85: Moody's Liquidity Stress Index and Default Rates

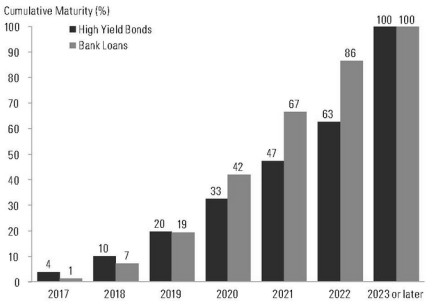
Leading indicators suggest the path of defaults for high yield is lower.



Data through November 30, 2016.
Note: Moody's Liquidity Stress Indexes fall when corporate liquidity appears to improve and rise when it appears to weaken.
Source: Investment Strategy Group, Moody's.

Exhibit 86: Cumulative US High Yield Debt Maturity by Year

Less than 10% of existing debt matures in the next two years.



Data as of December 31, 2016.
Source: Investment Strategy Group, JP Morgan.

experiencing liquidity problems or are at risk of breaching financial covenants. As seen in Exhibit 85, Moody's composite Liquidity Stress Index (LSI) began to deteriorate in advance of previous default cycles. Third, the commodity sectors of the high yield universe—which collectively generated a staggering 85% of last year's defaults—are recovering along with oil prices. Keep in mind that the par-weighted default rate excluding these sectors was just 0.5% last year, a fraction of the 3.2% long-run average.[117] Finally, our default model—which incorporates the leading characteristics of the Federal Reserve's Senior Loan Officer Opinion Survey and the percentage of distressed bonds—is projecting 2–3% par-weighted defaults in the year ahead.

Other factors corroborate our low-default view. As seen in Exhibit 86, there is very little refinancing risk, given that less than 10% of existing debt matures in the next two years. Of equal importance, interest coverage stands near all-time highs today, in stark contrast to the period preceding the financial crisis (see Exhibit 87). This point is further illustrated by Exhibit 88, which shows that today's high yield universe is much healthier than the pre-crisis cohort, regardless of measure. Keep in mind that low-rated CCC bonds represented just 8% of high yield issuance last year, a 14-year low.[118]

We also note that high yield may be a better interest rate hedge than many investors realize. Consider that during unexpected interest rate backups in the past, high yield has generated a positive return 69% of the time and a return that exceeded investment grade fixed income 85% of the time (see Exhibit 89). This last point is important, as our high yield overweight is funded out of investment grade fixed income. High yield's hedging qualities were apparent last year, as the asset class appreciated nearly 7% in the second half of the year despite an increase in Treasury yields of more than 100 basis points. Although we assume that any further increase in 10-year Treasury rates this year will not be offset by high yield spreads, this historical relationship suggests that may be overly conservative.

We think the strong fundamentals underpinning US corporate high yield still warrant an overweight, though returns are almost certain to be more modest going forward.

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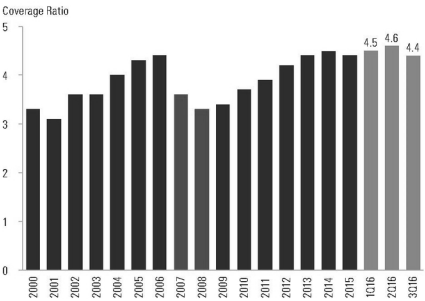
Exhibit 87: High Yield Par-Weighted Interest Coverage Ratio

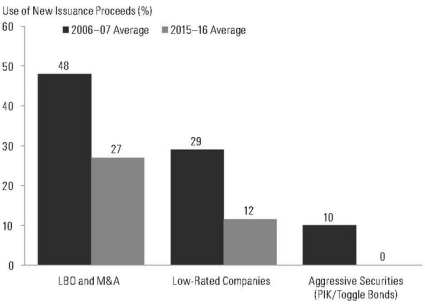
Interest coverage today stands near all-time highs, unlike the pre-crisis period.



Data through Q3 2016.
Source: Investment Strategy Group, Barclays.

Exhibit 88: Characteristics of US High Yield Issuance

Today's high yield universe is much healthier than the pre-crisis cohort.



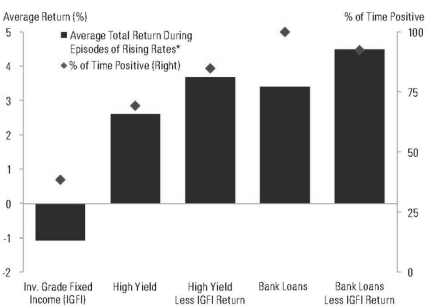
Data as of December 31, 2016.
Source: Investment Strategy Group, JP Morgan.

Of course, a more constructive view of high yield fundamentals does not necessarily suggest robust returns. In high yield bonds, today's below-average spreads already reflect our subdued default expectations and are less likely to offset any further increase in rates. We thus expect returns of around 4% in the year ahead. Although high yield energy is likely to generate similar gains, the potential upside is more significant given wider starting spreads and the potential for distressed bonds to pull to par amid higher oil prices. Finally, with a 5% return, bank loans should perform marginally better than bonds, reflecting their attractive 0.25-year duration and continued investor demand for floating rates—a feature that is back in vogue now that 3-month LIBOR is almost above the 1% LIBOR floor that more than 90% of bank loans possess.

While these returns may pale in comparison to those of last year, they remain attractive relative to investment grade fixed income, where we expect rising rates to generate lower returns. Even if rates stagnate while US growth remains positive, the default-adjusted return in high yield should still trump high-quality bonds. Said differently, US corporate high yield credit remains a better house in a bad fixed income neighborhood, supporting our modest overweight recommendation.

Exhibit 89: High Yield Credit Performance During Periods of Rising Rates

High yield has historically outperformed investment grade bonds during episodes of rising rates.



Data as of December 31, 2016.
Source: Investment Strategy Group, Barclays, Credit Suisse.
* Defined as 5-year Treasury yield rising more than 70 basis points over a 3-month period.

European Bonds

Unlike their US counterparts, European fixed income markets did not forfeit all their gains by the end of last year. This served as a poignant reminder of how divergent monetary policies can shape returns. Three ECB actions in March drove this robust relative performance. First, the ECB reversed its prior commitment to avoid

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further rate cuts and lowered the deposit rate to -0.40%. Second, it increased the size of its asset purchase program from €60 billion to €80 billion per month, effectively buying more Eurozone bonds each year than are actually issued (see Exhibit 90). Finally, it continued to limit its buying to bonds with yields above the deposit rate, which concentrated its purchases toward long-maturity bonds.

These measures created an extreme scarcity effect in long-term German bunds, as investors scrambled to buy today for fear of even lower interest rates tomorrow. In response, German 10-year rates fell to an all-time low of -18 basis points in July of 2016. During these same summer months, all German government bonds with less than a 15-year maturity offered negative yields.

However, monetary policy does not operate in a vacuum. With negative interest rates impairing the profitability of the European banking system, the ECB has already begun to alter its policy mix. At its December 2016 meeting, the ECB reversed the increase in asset purchases mentioned above, targeting €60 billion per month for the upcoming March–December 2017 period. Moreover, it lifted the restriction on purchasing bonds with yields below the deposit rate, alleviating the scarcity premium attached to long-maturity bonds meeting this criterion. While these adjustments are well short of QE "tapering," they have shifted the market focus toward the eventual end of asset purchases and the timing of the first ECB rate hike—currently priced for late 2018.

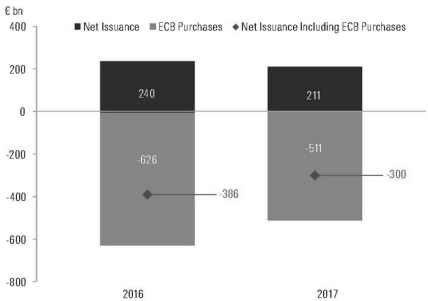
With less ECB policy pressure on long-maturity bonds, coupled with continued above-trend Eurozone growth and some further normalization in global term premiums, we expect 10-year bund yields to increase to 0.5–1.0% by the end of 2017. While overall peripheral bond spreads should be mostly range-bound in 2017, political woes in Italy and France pose upside risks to the spreads of those countries.

In the UK, we expect gilt yields to reach 1.5–2.25%. Here, persistently high headline inflation induced by the depreciation of sterling and a less-than-feared economic drag from Brexit thus far could encourage the BOE to unwind a portion of the preemptive easing it deployed in response to the surprise referendum outcome.

Given this outlook and today's still depressed bond yields, we remain underweight UK and Eurozone government bonds for European investors. After all, just a 2 basis point increase in German 10-year bund yields generates a capital loss sufficient to offset an entire year of income. That said, we should not confuse an underweight with a zero weighting, as European clients should retain some exposure to German bunds and other high-quality Eurozone bonds in the "sleep-well" portion of their portfolios. These high-quality bonds would provide an attractive hedge in the event of a Eurozone recession or the return of deflationary concerns.

Exhibit 90: European Government Bond Issuance and ECB Purchases

ECB buying is outpacing net issuance of Eurozone bonds.



Data as of December 31, 2016.
Source: Investment Strategy Group, JP Morgan.

Emerging Market Local Debt

Last year's 10% return for emerging market local debt (EMLD) provided some solace to those who have suffered through nearly three years of losses totaling more than 30%. But investors had to endure considerable volatility to realize this gain, as returns fluctuated between -4% and +18% in 2016. In fact, the asset class lost roughly 5% in just the last two months of the year.

This last point is important, since many of the tailwinds that drove EMLD's strong returns in the first half of 2016 reversed toward year-end and are likely to impact the asset class again in 2017. Here, we refer specifically to the resumption of Federal Reserve rate hikes, renewed US dollar appreciation and a resumption of Chinese renminbi depreciation against the dollar. Just as falling global interest rates helped the asset class for the first part of 2016, so too should the rising rates we expect

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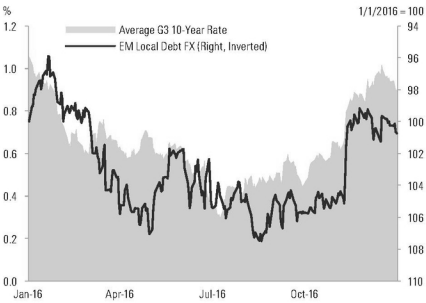
Exhibit 91: EM Local Debt Currencies and Developed Market Interest Rates

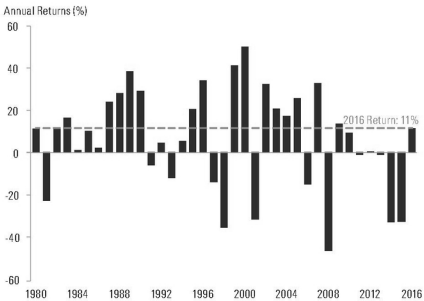
Rising global interest rates would be a headwind to EM local debt.



Data through December 31, 2016.
Source: Investment Strategy Group, Bloomberg, Datastream.

Exhibit 92: S&P Goldman Sachs Commodity Total Return Index

Commodities generated their first double-digit return since 2009.



Data through December 31, 2016.
Source: Investment Strategy Group, Bloomberg.

represent a headwind this year (see Exhibit 91). Meanwhile, any boost to emerging market exports from the modest pickup in global growth we expect is likely to be dwarfed by ongoing US trade policy uncertainty, European political risk and China fears. Lastly, an acceleration of recent outflows from EMLD markets could magnify these risks, particularly since 60% of the cumulative inflows into the asset class since 2004 are experiencing losses at current market levels.

Although the number of concerns is large, so is the risk premium of the asset class. As previously seen in Exhibit 76, the currencies in the EMLD index are 15% undervalued. From this starting point, the asset class could deliver attractive total returns if US trade policy proves to be more benign than feared and China worries abate.

Considering this balance of risks, our central case calls for low single-digit returns. While positive, this return is not sufficient to justify a tactical long position in EMLD in our view, given the still considerable downside risks discussed above.

Emerging Market Dollar Debt

Emerging market dollar debt (EMD) returned 10% in 2016, capping a surprising four-year period of outperformance that has greatly benefited from stable US rates and dollar strength. But the prospects for a fifth year of upside are questionable for several reasons.

First, EMD's almost seven-year duration is a liability in a rising-rate environment. This is particularly true now that the Federal Reserve has resumed tightening policy, a fact evident in EMD's 4.3% drop in response to increasing rate hike expectations late last year. Second, with spreads standing near two-year lows, there is scope for spread widening based on US and European policy uncertainty and renewed China growth fears. Third, countries accounting for 37% of EMD—including Mexico, China, South Africa and Brazil—have negative outlooks from at least two rating agencies, raising the potential for downgrades.[119] A potential default by Venezuela and its national oil company could also sour sentiment, as could unfavorable tariffs or trade restrictions from the new US administration. Finally, the backup in interest rates we expect could raise funding costs for EM corporate issuers, which could also heighten concerns about spillover into EMD. Indeed, a recent stress test by Standard & Poor's revealed that EM corporate borrowers—who must repay $200 billion per year through 2020[120]—are twice as susceptible to downgrades as US corporates if dollar funding costs rise by a third.[121]

Based on the above, we do not recommend a tactical position in EMD at this time.

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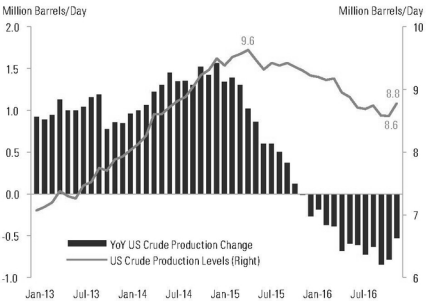
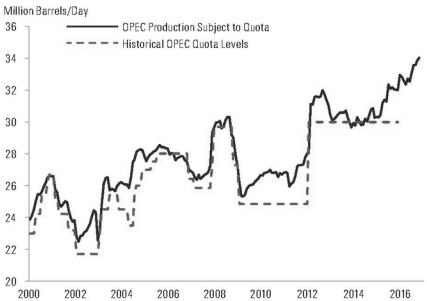
Exhibit 94: US Crude Oil Production
Supply has stabilized after declining by 1 million barrels/day from its peak.



Data through November 30, 2016.
Source: Investment Strategy Group, US Department of Energy.

Exhibit 95: OPEC Crude Oil Production
OPEC producers have exceeded their quota 90% of the time since 2000.



Data through November 30, 2016.
Source: Investment Strategy Group, Bloomberg.

2017 Global Commodity Outlook

After losing more than half its value in the span of two years, the S&P GSCI broke its downward trend with an 11% gain in 2016, its first double-digit return since 2009 (see Exhibit 92). The rebound in oil prices was a key contributor, as oil finished the year with a staggering 52% spot price gain—an outcome made all the more remarkable by the fact that oil was down 25% at its worst point early last year. This strength was not limited to the oil patch, as industrial metals rallied 17% on average and precious metals advanced 8% (see Exhibit 93).

Despite last year's broad-based gains, we are more circumspect about the outlook for 2017. While we expect oil to advance, it begins the year closer to the midpoint of our target range, providing a more balanced risk/reward profile. Meanwhile, we believe the key elements of our macroeconomic forecast—Federal Reserve tightening, rising interest rates, modest US dollar gains and average inflation—represent continued headwinds to gold prices. Comparable headwinds exist for industrial metals and agricultural goods, given the continued slowdown we expect in Chinese growth.

We discuss the specifics of our outlook for oil and gold in the sections that follow.

Oil: Regaining Its Balance

Oil is finding its footing again after having stumbled dramatically over the last two years. While the market is still awash in oil inventories, the sizable reductions in capital expenditures by the largest international oil and gas companies

Exhibit 93: Commodity Returns in 2016
Most commodity subcomponents saw positive returns in 2016, reversing several years of declines.

	S&P GSCI	Energy	Agriculture	Industrial Metals	Precious Metals	Livestock
Spot Price Average, 2016 vs. 2015	-10%	-14%	0%	-6%	8%	-17%
Spot Price Return	28%	48%	3%	19%	9%	-10%
Excess Return*	11%	18%	-5%	17%	8%	-8%

Data as of December 31, 2016.
Source: Investment Strategy Group, Bloomberg.
* Excess return corresponds to the actual return from being invested in the front-month contract and differs from spot price return, depending on the shape of the forward curve. An upward-sloping curve (contango) is negative for returns, while a downward-sloping curve (backwardation) is positive.

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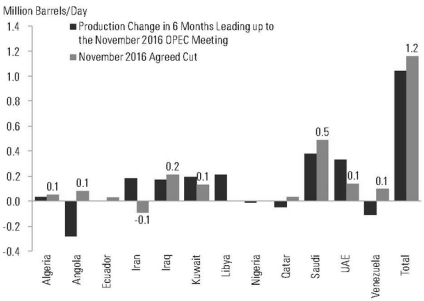
Exhibit 96: OPEC 2016 Production Cut Agreement and Recent Changes

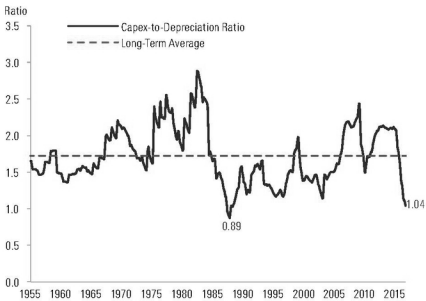
If fully implemented, OPEC's proposed cut would reverse production growth from the prior 6 months.



Data as of November 30, 2016.
Source: Investment Strategy Group, Bloomberg, OPEC.

Exhibit 97: US Energy Sector Ratio of Capital Spending (Capex) to Depreciation

Low capex levels suggest there is upside to investment.



Data through September 30, 2016.
Source: Investment Strategy Group, Empirical Research Partners.

suggest the transition toward a balanced market is underway. The same could be said for the dramatic cuts in US drilling budgets, which have precipitated notable declines in US shale output (see Exhibit 94). Lower oil prices have also supported above-average global demand growth, helping to absorb excess inventories. Lastly, OPEC agreed to lower production in November 2016, while also securing a promise from its significant non-OPEC counterparts to do the same. Taken together, these developments support our forecast for moderately higher oil prices in 2017.

This balancing act is still precarious, however. Oil inventories stand well above seasonal averages, so failure to honor the announced production cuts could delay the recovery in oil prices or, even worse, cause renewed declines. The risk of poor compliance is not trivial, given that producers have exceeded their quota 90% of the time by an average of 1 million barrels per day (mmbd) since 2000 (see Exhibit 95). The pledges from Russia and certain smaller non-OPEC producers are particularly suspect, as similar promises to cut their own output along with OPEC have been broken in the past.

Moreover, while the announced cuts are significant—the OPEC agreement would reduce production by up to 1.2 mmbd, equivalent to about one year of average global demand growth—they are largely a reversal of production growth seen over the last six months (see Exhibit 96). Meanwhile, Libya and Nigeria were excluded from these new OPEC quotas given sizable domestic disruptions that have depressed their production. Recent signs of improvement, however, suggest a rebound in their production cannot be dismissed. Therefore, the announced cuts are not a panacea to the current oil imbalance, particularly if US shale output increases meaningfully in response.

This last point is important, as US shale accounted for 60% of global production growth between 2012 and 2015 despite representing less than 5% of the total output. Although US production is now declining, two factors may arrest its slide in 2017. First, the breakeven price for shale drilling has fallen to an average of $50 per barrel, reflecting a 20% decline in production costs and improvements to the shale model, including faster drilling, larger wells and better resource recovery. In response, more than 200 oil rigs have been placed in service since their number troughed in May 2016.[122] Second, capital spending by the US energy sector is

Oil is finding its footing again after having stumbled dramatically over the last two years.

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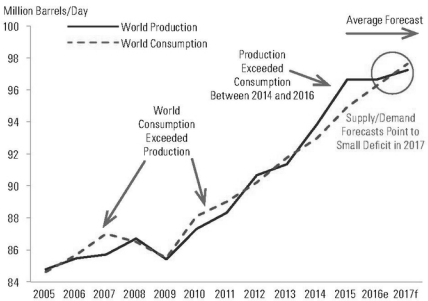
Exhibit 98: Full-Year Average Global Crude Oil Supply and Demand

Oil consumption in 2017 could exceed supply for the first time since 2013.



Data through December 31, 2016.
Source: Investment Strategy Group, Goldman Sachs Global Investment Research, International Energy Agency, OPEC, US Department of Energy, Energy Aspects, PIRA, Bloomberg, Barclays, JP Morgan.

Exhibit 99: Gold Prices and US 10-Year Real Interest Rates

Gold prices and real interest rates are closely linked.

Data through December 31, 2016.
Source: Investment Strategy Group, Bloomberg.

very depressed despite the recent uptick in rigs, providing scope for further increases (see Exhibit 97). As a result, we expect shale production to recover in 2017, partially offsetting cuts elsewhere.

Despite these potentially destabilizing forces, we still think the oil market can swing to a small deficit this year. While lower input costs create upside risks to US shale production, these costs are highly correlated with oil itself. As a result, today's $50 average breakeven level for shale is likely to move higher with oil prices, limiting the rebound in US production. Moreover, even if just half of the proposed production cuts are realized, our work suggests the oil market will still switch into a deficit this year. Finally, OPEC spare capacity has been largely exhausted by the production increases of the last year, while Iran's production has now returned to pre-sanction levels. In turn, the risk of another disorderly market-share battle has declined significantly.

Against this backdrop, we expect oil supply growth to moderate and enable oil demand to again exceed oil production, creating the first deficit since 2013 (see Exhibit 98). With balance restored, we expect oil to trade in a $45–65 range in the year ahead. Thus we continue to recommend an overweight to US high yield energy bonds and US MLPs.

Gold: Still Searching for Its Luster

Gold was not immune from the reversal of fortune that befell interest rates last year, reminding us that their fates are fundamentally linked (see Exhibit 99). Put simply, higher interest rates raise the opportunity cost of holding gold, since the yellow metal generates no cash flow and must be physically stored, often at a cost. A similarly inverse relationship exists with the US dollar, as investors often purchase gold as a hedge against the debasement of fiat currencies; gold has traded inversely to the dollar index 73% of the time on an annual basis over the last 40 years.

Given these relationships, we believe the key elements of our macroeconomic forecast—Federal Reserve tightening, rising interest rates, modest US dollar gains and average inflation—will represent headwinds for the yellow metal in 2017. Keep in mind that gold prices have declined in four of the last five Federal Reserve tightening cycles, with the only exception occurring during a period of dollar weakness in the mid-2000s. Based on these precedents, our expectation of two or three Federal Reserve rate increases in 2017 does not bode well for gold prices.

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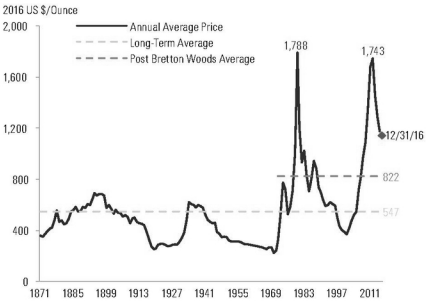
Exhibit 100: Average Annual Gold Prices

Gold remains expensive relative to its inflation-adjusted long-term average price.



Data through December 31, 2016.
Source: Investment Strategy Group, Bloomberg.

The same could be said of continued outflows from gold exchange-traded funds (ETFs). We estimate that a net 280 tonnes of gold ETF holdings—an amount even larger than the 210 tonnes of ETF outflows that pressured gold prices in late 2016—were purchased over the past year at levels above today's price. Absent a rebound in gold prices, these ETF holders might prefer to realize their losses and rotate into instruments with a yield component. Value-minded investors should also consider that gold prices remains well above their long-term average (see Exhibit 100).

Despite this challenging outlook, a number of factors could still buoy gold prices in the year ahead. Emerging market central banks have continued to buy gold to diversify their reserves. Moreover, the stronger global growth we expect could lift jewelry demand, particularly in gold's two largest end markets—China and India. Finally, gold's allure as an inflation hedge could come back into focus if the market begins to worry about economic overheating in the US, although this is not our base case.

In light of these crosscurrents, we are tactically neutral on gold at this time.

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In Closing

WE DO NOT BELIEVE THE COMING YEAR WILL BRING AN END to the prolonged run of positive performance for either the US economy or the bull market for equities. Despite greater uncertainties, including those tied to a new US administration, the policy backdrop in the US will likely prove particularly favorable for the economy, with looser fiscal policy, still easy monetary policy and a lighter regulatory burden. As these factors diminish the probability of recession in 2017, they also support the case for clients remaining invested in global equities at their strategic allocation. We believe US equity gains are likely to be modest but still more attractive than the comparable returns of investment alternatives such as cash and bonds. And, as last year demonstrated, US equities often surprise to the upside.

While we see the glass as half-full, there is no shortage of risks—some of which have high probability and uncertain impact for the year ahead—that could cause our forecasts for the economy and asset class returns to miss the mark. As always, we will adjust and communicate our views accordingly should the economic, financial or geopolitical backdrop change materially over the course of 2017.

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Abbreviations Glossary

ACA: Affordable Care Act

BEA: Bureau of Economic Analysis
BIS: Bank for International Settlements
BLS: Bureau of Labor Statistics
BOE: Bank of England
BOJ: Bank of Japan

CAGR: compound annual growth rate
CDS: credit default swap
CFO: chief financial officer
CFTC: Commodity Futures Trading Commission
CPI: consumer price index

EAFE: Europe, Australasia and the Far East
ECB: European Central Bank
EM: emerging market
EMD: emerging market dollar debt
EMLD: emerging market local debt
EMEA: Europe, the Middle East and Africa
EMU: European Monetary Union
EPS: earnings per share
ETF: exchange-traded fund

FTSE: Financial Times Stock Exchange
FX: Foreign Exchange

GBP: British pound
GDP: gross domestic product
GFC: global financial crisis
GIR: [Goldman Sachs] Global Investment Research
GPIF: Government Pension Investment Fund
GSCI: Goldman Sachs Commodity Index

IGFI: Investment grade fixed income
IMF: International Monetary Fund
ISIL: Islamic State of Iraq and the Levant
ISM: Institute of Supply Management
JGB: Japanese government bond

LBO: leveraged buyout
LIBOR: London Interbank Offered Rate
LSI: Liquidity Stress Index

M&A: merger and acquisition
MLP: master limited partnership
mmbd: million barrels per day
MSCI: Morgan Stanley Capital International

NAHB: National Association of Home Builders
NATO: North Atlantic Treaty Organization
NBER: National Bureau of Economic Research
NIPA: national income and product accounts
NIRP: negative interest rate policy

OECD: Organisation for Economic Co-operation and Development
OPEC: Organization of the Petroleum Exporting Countries

PBOC: People's Bank of China
PCE: personal consumption expenditures
PE: price to earnings
PPI: Producer Price Index
PPP: purchasing power parity
QE: quantitative easing

S&P: Standard and Poor's

TIPS: Treasury Inflation-Protected Securities
TOPIX: Tokyo Price Index

UK: United Kingdom
US: United States

VAT: value-added tax

YoY: year-over-year

Notes

1. Jeremy J. Siegel, *Stocks for the Long Run: The Definitive Guide to Financial Market Returns and Long-Term Investment Strategies*, McGraw-Hill, 1994.
2. Lisa Beilfuss, "As Dow Nears 20000, Stock-Market Believer Jeremy Siegel Gets a 'Told You So' Moment," *Wall Street Journal*, December 10, 2016.
3. Throughout the text, "post-WWII cycles" refers to expansions beginning in Q2 1954. We exclude two prior expansions, beginning in Q4 1945 and Q4 1949, to ensure consistent data across all variables used to analyze the duration and strength of recoveries (some data series are only available since 1950) as well as to avoid contaminating summary statistics given idiosyncratic economic policies that followed the end of WWII (such as the sharp reduction in military spending or the GI Bill). Our takeaway from the analysis would not change if 1945 and 1949 were included for the series for which data is available.
4. Edward Luce, "Goodbye to Barack Obama's World," *Financial Times*, November 27, 2016.
5. John H. Cochrane, "Ending America's Slow-Growth Tailspin," *Wall Street Journal*, May 2, 2016.
6. Martin Wolf, "New President Has an Economic In-Tray Full of Problems," *Financial Times*, November 8, 2016.
7. Michael Heath, "Summers Urges U.S. to Spend 1% of GDP Annually on Infrastructure," Bloomberg, October 18, 2016.
8. Robert J. Gordon, *The Rise and Fall of American Growth: The U.S. Standard of Living Since the Civil War*, Princeton University Press, 2016.
9. Marc Levinson, *An Extraordinary Time: The End of the Postwar Boom and the Return of the Ordinary Economy*, Basic Books, 2016.
10. Martin Jacques, *When China Rules the World: The End of the Western World and the Birth of a New Global Order*, Penguin Press, 2009.
11. N. Gregory Mankiw, "One Economic Sickness, Five Diagnoses," *New York Times*, June 17, 2016.
12. Carmen M. Reinhart and Kenneth S. Rogoff, *This Time Is Different: Eight Centuries of Financial Folly*, Princeton University Press, 2011.
13. Alvin H. Hansen, "Capital Goods and the Restoration of Purchasing Power," Academy of Political Science, 1934.
14. Alvin H. Hansen, "Economic Progress and Declining Population Growth," *American Economic Review*, 1939.
15. Lawrence H. Summers, "Remarks," speech delivered at the Fourteenth Jacques Polak International Monetary Fund Annual Research Conference, Washington, D.C., November 8, 2013.
16. Jay Shambaugh, "How Should We Think About This Recovery?" Macroeconomic Advisers' 26th Annual Policy Seminar, Washington, D.C., September 14, 2016.
17. Michael E. Porter, Jan W. Rivkin, Mihir A. Desai and Manjari Raman, "Problems Unsolved and a Nation Divided," Harvard Business School, September 2016.
18. Council of Economic Advisers, "The Long-Term Decline in Prime-Age Male Labor Force Participation," June 2016.
19. Ibid.
20. Etienne Gagnon, Benjamin K. Johannsen and David Lopez-Salido, "Understanding the New Normal: The Role of Demographics," Board of Governors of the Federal Reserve System, October 3, 2016.
21. Mitra Toossi, "A Century of Change: The U.S. Labor Force, 1950-2050," *Monthly Labor Review*, Bureau of Labor Statistics, May 2002.
22. Donald J. Trump, "Remarks," speech delivered at the New York Economic Club, September 15, 2016.
23. Chair Janet L. Yellen, "Current Conditions and the Outlook for the U.S. Economy," June 6, 2016. Vice Chairman Stanley Fischer, "Remarks on the U.S. Economy," August 21, 2016.
24. Robert J. Gordon, *The Rise and Fall of American Growth: The U.S. Standard of Living Since the Civil War*, Princeton University Press, 2016.
25. Stephanie H. McCulla, Alyssa E. Holdren and Shelly Smith, "Improved Estimates of the National Income and Product Accounts: Results of the 2013 Comprehensive Revision," Bureau of Economic Analysis, September 2013.
26. Paul Krugman, *The Age of Diminished Expectations: U.S. Economic Policy in the 1990s*, MIT Press, 1990.
27. Lee Branstetter and Daniel Sichel, "Seven Reasons to Be Optimistic About Productivity," forthcoming.
28. Ibid.
29. Olivier Blanchard, "The State of Advanced Economies and Related Policy Debates: A Fall 2016 Assessment," Peterson Institute for International Economics, September 2016.
30. Martin Feldstein, "Remarks," speech delivered at the Brookings Institution Conference on Productivity, Washington, D.C., September 8, 2016.
31. Jan Hatzius, "Productivity Paradox v2.0 Revisited," Goldman Sachs Global Investment Research, September 2, 2016.
32. David M. Byrne, Stephen D. Oliner and Daniel E. Sichel, "How Fast Are Semiconductor Prices Falling?" Federal Reserve Board, March 2015.
33. Hal Varian, "A Microeconomist Looks at Productivity: A View from the Valley," September 2016.
34. Ibid.
35. Hal Varian, "Notes on Productivity and Intangibles," November 2016.
36. Chad Syverson, "Challenges to Mismeasurement Explanations for the U.S. Productivity Slowdown," University of Chicago Booth School of Business, June 2016.
37. David M. Byrne, John G. Fernald and Marshall B. Reinsdorf, "Does the United States Have a Productivity Slowdown or a Measurement Problem?" Brookings Institution, March 1, 2016.
38. David Byrne and Carol Corrado, "ICT Prices and ICT Services: What Do They Tell Us About Productivity and Technology?" Conference Board, July 2016.
39. David Byrne, Wendy Dunn and Eugenio Pinto, "Prices and Depreciation in the Market for Tablet Computers," Federal Reserve Board, December 2016.
40. Greg Ip, "The Economy's Hidden Problem: We're Out of Big Ideas," *Wall Street Journal*, December 5, 2016.
41. Johan Norberg, *Progress: Ten Reasons to Look Forward to the Future*, Oneworld Publications, 2016.
42. Fredrik Erixon and Björn Weigel, *The Innovation Illusion: How So Little Is Created by So Many Working So Hard*, Yale University Press, 2016.
43. N. Gregory Mankiw, "One Economic Sickness, Five Diagnoses," *New York Times*, June 17, 2016.
44. Alan S. Blinder and Mark W. Watson, "Presidents and the U.S. Economy: An Econometric Exploration," Princeton University, July 2014.
45. Jay Shambaugh, "How Should We Think About This Recovery?" Macroeconomic Advisers' 26th Annual Policy Seminar, Washington, D.C., September 14, 2016.
46. Lawrence H. Summers, "When the Best Umps Blow a Call," *Washington Post*, July 14, 2016.
47. Martin Neil Baily and Nicholas Montalbano, "Why Is US Productivity Growth So Slow? Possible Explanations and Policy Responses," Brookings Institution, September 1, 2016.
48. Kevin Daly, "Arrested Development: EMs Are Still Converging, but Productivity Growth Is Lower Everywhere," Goldman Sachs Global Investment Research, December 20, 2016.
49. Molly E. Reynolds and Philip A. Wallach, "The Fiscal Fights of the Obama Administration: An Interactive Timeline," Brookings Institution, December 8, 2016.
50. As measured by the Goldman Sachs Financial Conditions Index.
51. "Default Monitor," JP Morgan, December 1, 2016.
52. Investment Strategy Group, *Outlook: The Last Innings*, January 2016.

53. These forecasts have been generated by ISG for informational purposes as of the date of this publication. Total return targets are based on ISG's framework, which incorporates historical valuation, fundamental and technical analysis. Dividend yield assumptions are based on each index's trailing 12-month dividend yield. They are based on proprietary models and there can be no assurance that the forecasts will be achieved. Please see additional disclosures at the end of this publication. The following indices were used for each asset class: Barclays Municipal 1-10Y Blend (Muni 1-10); BAML US T-Bills 0-3M Index (Cash); JPM Government Bond Index Emerging Markets Global Diversified (Emerging Market Local Debt); HFRI Fund of Funds Composite (Hedge Funds); MSCI EM US$ Index (Emerging Market Equity); Barclays US Corporate High Yield (US High Yield); Barclays US High Yield Loans (Bank Loans); MSCI UK Local Index (UK Equities); MSCI EAFE Local Index (EAFE Equity); S&P Banks Select Industry Index (US Banks); TOPIX Index (Japan Equity); Barclays High Yield Municipal Bond Index (Muni High Yield).

54. LIBOR, the London Interbank Offered Rate, is calculated as the average of leading banks' estimates of the interest rates that they would be charged were they to borrow from other banks. It is one of the primary benchmarks for global short-term interest rates.

55. Spain is the only Eurozone country in which all banks clear all of the following capital hurdles: (1) CET1 ratio >100 bps above each bank's hurdle rate (5.5% + GSIB buffer, where applicable); (2) 4% leverage ratio in the ECB stress test base case scenario; and (3) 2% leverage ratio in the ECB stress test adverse scenario. Jernej Omahen, "Stress Test: Worst Fears Avoided; Capital Divergence Widens," Goldman Sachs Global Investment Research, July 31, 2016.

56. Gideon Rachman, "Marine Le Pen Looms Over a Trumpian World," *Financial Times*, November 21, 2016.

57. Charles Lichfield, "Fillon Presidency Now More Likely Than a Juppé One," Eurasia Group, November 21, 2016.

58. Charles Lichfield, "Attack Demonstrates Merkel's Vulnerability in 2017," Eurasia Group, December 20, 2016.

59. Alastair Gale and Kwanwoo Jun, "North Korea Says It Successfully Conducted Hydrogen-Bomb Test," *Wall Street Journal*, January 6, 2016.

60. Kwanwoo Jun, "North Korea Launches Missile From Submarine," *Wall Street Journal*, April 24, 2016.

61. Alastair Gale and Gordon Lubold, "North Korea Missile Launch Portends Growing Capabilities," *Wall Street Journal*, June 22, 2016.

62. Alastair Gale and Carol E. Lee, "North Korea Conducts Fifth Nuclear Test," *Wall Street Journal*, September 9, 2016.

63. Mike Mullen, Sam Nunn and Adam Mount, "A Sharper Choice on North Korea: Engaging China for a Stable Northeast Asia," Council on Foreign Relations, Independent Task Force Report No. 74, September 2016.

64. David Gordon (adjunct senior fellow at the Center for a New American Security), in a conference call with the Investment Strategy Group, December 15, 2016.

65. Gerald F. Seib, Jay Solomon and Carol E. Lee, "Barack Obama Warns Donald Trump on North Korea Threat," *Wall Street Journal*, November 22, 2016.

66. Andrew E. Kramer, "As New Ukraine Talks Begin, What Is the State of Europe's Only Active War?" *New York Times*, October 19, 2016.

67. Warsaw Summit Communiqué, issued by the heads of state and government participating in the meeting of the North Atlantic Council in Warsaw, July 8–9, 2016.

68. Thomas Gibbons-Neff, "2,900 Explosions in a Day. Heavy Artillery and Tank Fire Returns to the Front Lines in Ukraine." *Washington Post*, December 20, 2016.

69. Warsaw Summit Communiqué, issued by the heads of state and government participating in the meeting of the North Atlantic Council in Warsaw, July 8–9, 2016.

70. "Transcript: Donald Trump on NATO, Turkey's Coup Attempt and the World," *New York Times*, July 21, 2016.

71. Ben Hubbard and David E. Sanger, "Russia, Iran and Turkey Meet for Syria Talks, Excluding US," *New York Times*, December 20, 2016.

72. John Davison and Stephanie Nebehay, "Syrian Peace Talks Limp on to Next Week with Opposition Absent," Reuters, April 22, 2016.

73. Anne Barnard, "Death Toll From War in Syria Now 470,000, Group Finds," *New York Times*, February 11, 2016.

74. Jessica Hartogs, "Syria War Could Cost Country $1.3T by 2020: Study," CNBC, March 8, 2016.

75. Zalmay Khalilzad, "America Needs a Bipartisan Foreign Policy. Donald Trump Can Make It Happen," *National Interest*, December 21, 2016.

76. Geoff Dyer, "Trump's CIA Nominee Mike Pompeo Promises to Roll Back Iran Deal," *Financial Times*, November 18, 2016.

77. General (Ret.) James N. Mattis, speech delivered at a conference at the Center for Strategic and International Studies, "The Middle East at an Inflection Point with Gen. Mattis," April 22, 2016.

78. Ibid.

79. Carol E. Lee and Jay Solomon, "Obama Seeks to Fortify Iran Nuclear Deal," *Wall Street Journal*, November 20, 2016.

80. Kristina Peterson, "House Passes 9/11 Bill That Would Let Victims' Families Sue Saudi Arabia," *Wall Street Journal*, September 9, 2016.

81. Melissa Eddy and Alison Smale, "Berlin Crash Is Suspected to Be a Terror Attack, Police Say," *New York Times*, December 19, 2016.

82. Tom Burgis, Arthur Beesley and Anne-Sylvaine Chassany, "ISIS Claims Responsibility for Attack in Nice," *Financial Times*, July 17, 2016.

83. Pervaiz Shallwani and Devlin Barrett, "How Police Tracked Down Bombing Suspect Ahmad Khan Rahami," *Wall Street Journal*, September 20, 2016.

84. Ben S. Bernanke, "How Do People Really Feel About the Economy?" Brookings Institution, June 30, 2016.

85. Joint Statement, Department of Homeland Security and Office of the Director of National Intelligence on Election Security, October 7, 2016.

86. Courtney Weaver, Sam Fleming and Kathrin Hille, "US Expels Russian Spies over Election Hacking," *Financial Times*, December 29, 2016.

87. Vindu Goel and Nicole Perlroth, "Yahoo Says 1 Billion User Accounts Were Hacked," *New York Times*, December 14, 2016.

88. Laura Sanders, "IRS Says Cyberattacks on Taxpayer Accounts More Extensive Than Previously Reported," *Wall Street Journal*, February 26, 2016.

89. Dustin Volz and Jason Lange, "Exclusive: FBI Probes FDIC Hack Linked to China's Military – Sources," Reuters, December 23, 2016.

90. Daniel Victor, "LinkedIn Says Hackers Are Trying to Sell Fruits of Huge 2012 Data Breach," *New York Times*, May 18, 2016.

91. Jamil Anderlini, "Beijing Clamps Down on Forex Deals to Stem Capital Flight," *Financial Times*, September 9, 2015.

92. Frank Tang, "China's Foreign Reserves Fall Again in November Even as Beijing Tightens Screws on Capital Outflows," *South China Morning Post*, December 7, 2016.

93. Wendy Wu, "What China Has Done to Stop Massive Amounts of Cash from Fleeing the Country," *South China Morning Post*, December 9, 2016.

94. Marcus Noland, Gary Clyde Hufbauer, Sherman Robinson and Tyler Moran, "Assessing Trade Agendas in the US Presidential Campaign," Peterson Institute for International Economics, September 2016.

95. Robert D. Blackwill, Henry Kissinger and Ashley J. Tellis, "Revising U.S. Grand Strategy Toward China," Council on Foreign Relations Press, April 2015.

96. David Brunnstrom, "China Installs Weapons Systems on Artificial Islands," Reuters, December 15, 2016.

97. Mark Landler and David E. Sanger, "Trump Speaks with Taiwan's Leader, an Affront to China," *New York Times*, December 2, 2016.

98. Kate O'Keeffe and Damian Paletta, "Tensions Linger Over Seizure of Survey Drone in South China Sea," *Wall Street Journal*, December 18, 2016.

99. Based on aggregated balance sheet data for the Federal Reserve, European Central Bank, Bank of Japan, Bank of England, Swiss National Bank and People's Bank of China. Source: Bloomberg, Datastream.

100. Federal Reserve Board Chair Janet Yellen, exchange with ABC News reporter Rebecca Jarvis, December 2015.

101. Federal Reserve Chair Janet Yellen, "The Economic Outlook and Monetary Policy," speech delivered at the Economic Club of Washington, December 2, 2015.

102. Based on Goldman Sachs Global Investment Research estimates.

103. Based on the European Commission investment survey.

104. Arnold Palmer, www.arnoldpalmer.com/bio.

105. Beginning in September 1945.

106. Elroy Dimson, Paul Marsh and Mike Staunton, *Triumph of the Optimists: 101 Years of Global Investment Returns*, Princeton University Press, 2002. © 2013 Elroy Dimson, Paul Marsh and Mike Staunton. As cited in *Credit Suisse Global Investment Returns Yearbook 2013*, February 2013.

107. December 2016 FOMC Statement of Economic Projections.

108. Peter Oppenheimer, "'Fat & Flat' with a Resurgence of Divergence," Goldman Sachs Global Investment Research, December 5, 2015.

109. Anna Kitanaka, Yuji Nakamura and Toshiro Hasegawa, "The Bank of Japan's Unstoppable Rise to Shareholder No. 1," Bloomberg, August 14, 2016.

110. As evidenced by SoftBank's recent pledge to invest $50 billion in the US. Michael J. de la Merced, "After Meeting Trump, Japanese Mogul Pledges $50 Billion Investment in the U.S.," *New York Times*, December 6, 2016.

111. The Plaza Accord was an agreement between the governments of France, West Germany, Japan, the United States and the United Kingdom to depreciate the US dollar in relation to the Japanese yen and German Deutsche Mark by intervening in currency markets. Source: Jeffrey Frankel, "The Plaza Accord, 30 Years Later," Harvard Kennedy School, December 10, 2015.

112. Stu Wood, Rick Carew and Eva Dou, "SoftBank to Buy ARM Holdings for $32 Billion," *Wall Street Journal*, July 18, 2016.

113. Since April 1946.

114. Karen Reichgott, "Fiscal Policy: A Modest Boost to Global Growth in 2017," Goldman Sachs Global Investment Research, December 8, 2016.

115. Sources: Citi, Barclays, Morgan Stanley, JP Morgan.

116. Bank of America, "2016 Outlook: May the Odds Be Ever in Your Favor," November 24, 2015.

117. Matthew Jozoff and Alex Roever, "US Fixed Income Markets – 2017 Outlook," JP Morgan, November 23, 2016.

118. Lofti Karoui, "Credit Notes: 2016: The Year of Extremes in 20 Charts," Goldman Sachs Global Investment Research, December 20, 2016.

119. Rating agencies referenced are Moody's, Standard & Poor's and Fitch Ratings.

120. Yang-Myung Hong, Alisa Meyers and Zubair K. Syed, "2017 Outlook – Clouds of Uncertainty Shroud the Outlook in Fat Tails," JP Morgan, November 2016.

121. Standard & Poor's,"Rising Interest Spreads, US Corporates Would Fare Better than Others," December 2016.

122. Data is from Baker Hughes rig counts.

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Q1 Top 10 Ideas

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Top 10 US Ideas – 1Q17

The backdrop for risk assets has changed dramatically over the past year. As Michael Hartnett pointed out, 2016 saw global interest rates fall to 5,000-year lows and the likely end of what has been the greatest bull market in bonds ever. We experienced a historic US Presidential election and Republican sweep of Congress on November 9th. Later that same month, OPEC reached a historic deal to reduce crude production by 1.2mn b/d with non-OPEC producers delivering an additional 600k b/d of cuts – the first such joint curb since 1998. Risk assets responded with 30-year Treasury reaching a yield of 2.088% in July, US equity markets reaching all-time highs, and oil prices rallying more than 40% since the start of the year. Given the Republican sweep - and the resulting likelihood that the logjam of Washington gridlock will be broken - our Top 10 stock selections are more heavily geared toward companies that may benefit from increased fiscal stimulus, a more pro-business agenda, and/or tax-policy reform. Our current strategy stands in stark contrast to our stance last year of looking for defensive growth ideas.

Eight Buys and two Underperforms

Our 1Q17 list includes eight Buys and two Underperforms across six sectors. Our Buys are Aetna Inc, Dover Corp, General Dynamics, Hess, MGM Resorts, Norfolk Southern, SVB Financial, and Texas Instruments. Our Underperforms are Consolidated Edison, and TripAdvisor.

How the list will be maintained and updated

We will publish this list at the beginning of each quarter. Ideas will generally remain on the list through the quarter unless coverage is dropped or the recommendation changes. Any security which is removed will not be replaced. If there are any changes to the list during the quarter we will publish the change in a research report. Securities are intended to stay on the list for one quarter, though some may be chosen for the next quarter's list. We will publish performance quarterly

Table 1: Top 10 US Ideas List – 1Q17

Company	Ticker	Analyst	Rating	Recommendation	Price	PO	Mkt Cap (bn)
Aetna Inc	AET	Fischbeck,Kevin	B-1-7	BUY	$124.45	$149.00	$44,657.00
Dover Corp	DOV	Obin,Andrew	B-1-7	BUY	$75.19	$85.00	$11,921.00
General Dynamics	GD	Epstein,Ronald J.	B-1-7	BUY	$173.21	$200.00	$57,215.00
Hess	HES	Leggate,Doug	B-1-7	BUY	$62.90	$80.00	$19,090.00
MGM Resorts	MGM	Kelley,Shaun	C-1-9	BUY	$28.50	$33.00	$11,993.00
Norfolk Southern	NSC	Hoexter,Ken	B-1-7	BUY	$108.82	$122.00	$33,393.00
SVB Financial	SIVB	Poonawala,Ebrahim	B-1-9	BUY	$170.38	$190.00	$8,584.00
Texas Instr.	TXN	Arya,Vivek	B-1-7	BUY	$74.15	$82.00	$73,899.00
Consolidated Edison	ED	Chin,Brian	A-3-7	UNDERPERFORM	$74.07	$59.00	$20,526.00
TripAdvisor	TRIP	Schindler,Nat	C-3-9	UNDERPERFORM	$46.95	$41.00	$9,071.00

Source: BofA Merrill Lynch Global Research

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Timestamp: 03 January 2017 12:05AM EST

Top 10 US Ideas Quarterly

Our Top 10 US Ideas are based on our view that these companies could have the most significant market and business related catalysts over the next three months. The list reflects primarily a bottoms-up approach, with calendar-specific events noted for most stocks. We constructed our list by canvassing BofAML Fundamental Equity Research analysts in order to find 10 BofAML-covered stocks which we think will significantly outperform or underperform peers during the quarter. We considered only Buy-rated names for outperform ideas and Underperform-rated names for underperform ideas. We then narrowed the list after consulting our Equity Research colleagues.

To be eligible for the list, the stock must be covered by BofA Merrill Lynch AMRS fundamental equity analysts with a rating of Buy or Underperform, for long and short stock recommendations, respectively.

Stocks will be chosen on a discretionary basis by the Alpha Generation team, which currently includes strategists with experience choosing stocks for BofAML's US 1 list. Stocks will be chosen for the list using a bottoms-up approach after taking into account the views of the relevant BofA Merrill Lynch Fundamental Equity analyst and upcoming catalysts. Diversity of the list and BofAML macro views will also be factors in choosing stocks for the list.

Stocks on the list will generally remain on the list during the quarter. However, a stock will be removed interim quarter if considered ineligible due to a change in the stock's fundamental rating, or if the stock is no long covered by BofA Merrill Lynch fundamental Equity Research. When stocks are removed during the quarter, they will not be replaced. Stocks will generally be removed from the list at the end of the quarter in conjunction with the publication of the next quarter's list, but may on select occasions remain on the list if the identified catalyst remains relevant or a new catalyst is expected to drive the requisite over/under performance. Any intra-quarter actions to the list will be announced in a research report.

The Top 10 list will be published on or close to the first day of each quarter. In addition, we may also publish research reports updating the catalysts' status or other news on particular stocks during the quarter.

How the list will be maintained and updated

We will publish this list at the beginning of each quarter. Ideas will generally remain on the list through the quarter unless coverage is dropped or the recommendation changes. Any security which is removed will not be replaced. If there are any changes to the list during the quarter we will promptly publish a note explaining the change. Securities are intended to stay on the list for one quarter, though some may be chosen again for the next quarter's list.

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Aetna (AET)

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Buy, PO $149

1Q investment thesis

Based on past precedence, our view is that the AET/HUM deal is more likely than not to be approved by the courts (ruling likely to come in January 2017). PF 2018 earnings should be close to $11.50 (vs $9.70 consensus), even before taking into account the upside from tax reform (+15% to EPS) and rising interest rates (+5%). In the event that the deal breaks, we see little downside and potential upside in 1Q17 in the form of capital deployment (AET remains underlevered and in the absence of a deal could look to aggressively repurchase stock). Current estimates do not include share repurchase and based on its history of repurchasing shares using free cash flow and its balance sheet capacity, we expect AET to repurchase a significant amount (~10%) of its shares in 2017 post deal break, providing initial downside support and ultimately driving upside to Street estimates.

Table 1: Aetna key stock data

Industry	Managed Care
Market Cap (mn)	$44,657
Price	$124.45
P/E (2017)	14.4x
% of sell-side rated Buy	70.0%
Short interest % of float	2.25%

Source: Bloomberg and BofA Merrill Lynch Global Research estimates

Deregulation/Gov't Legislation: Repeal and Replace of the ACA creates some uncertainty, but neither AET nor HUM derive a significant amount of EPS from the ACA. Meanwhile, Republicans have historically supported Medicare Advantage (80% of HUM's revenue), and we expect a stronger rate environment under this Administration than over the past 8 years.

Tax Policy: As a domestic only company with a relatively high tax rate (est. 35% in 2017), AET would benefit from tax reform. We believe that some benefit would be lost to minimum MLR rebates or competition, but if taxes are lowered 15%, then we assume that they keep about 2/3 of the benefit (19% to EPS).

Catalysts: Deal resolution, capital allocation update, tax reform, rising interest rates.

Latest report: MCO rally has just begun; beneficiaries of the non-Health Care upside from Trump

1Q risks: Risks to the downside are courts not approving the HUM acquisition, lower-than-expected membership growth and higher than expected cost trend. CMS will issue the rate update for 2018 for Medicare Advantage in late February, a reg which we expect to be benign, but which could be worse than expected.

Company Description: Aetna is one of the nation's largest managed care organizations, covering roughly 23 million members. The company focuses on three main business segments: Health Care (health insurance, dental, behavioral health and pharmacy benefit

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products), Group Insurance (including life, disability and long term care insurance products) and Large Case Pension (a legacy business which is largely in runoff).

Dover (DOV)

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Buy, PO $85

1Q investment thesis

We think the Street is underestimating '17 EPS upside potential from Energy recovery given the segment's close correlation to N.A. rig count and short-cycle nature of the business, as well as incremental accretion from Wayne acquisition. DOV is expected to host an analyst dinner on January 12th which will provide a 4Q update and preview 2017 results. We think the meeting will be a positive catalyst for the stock, providing more visibility on Energy orders post-OPEC meeting, highlighting sustainability of the EMV cycle in Wayne into '19. Investors will also likely get an update on execution turnaround in the Refrigeration business, removing one of the biggest overhangs on the stock.

Table 1: Dover key stock data

Industry	Industrial Machinery
Market Cap (mn)	$11,921
Price	$75.19
P/E (2017)	19.6x
% of sell-side rated Buy	25.0%
Short interest % of float	1.54%

Source: Bloomberg and BofA Merrill Lynch Global Research estimates

Deregulation/Gov't Legislation:

We expect Trump's administration to prioritize US energy independence, with deregulation benefiting domestic shale produces, which should be an attractive tailwind to DOV's Energy segment.

Tax Policy:

Our estimates are based on 29% tax rate in '17/18. We calculate that under Ryan's proposed plan, we can see about 19% upside to EPS. We estimate that under Trump's proposed plan, we can see about 24% upside to EPS.

Catalysts:

January 12th – investor dinner with management
January 26th – 4Q results
Rig count release

Latest report: Dover Corp: Adjusting for Wayne, EMV cycle extension; Rig count going up, LII read-across

1Q risks: With so much of DOV's EPS upside tied to Energy segment recovery, we view oil price volatility (from stronger US$ or other unexpected macro headlines) as the biggest risk to our thesis. Weaker-than-expected execution in Refrigeration or Fluid business would be another risk, offsetting Energy upside.

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Company Description: Dover is a diversified, global manufacturer of industrial products. It comprises more than 30 independent companies that operate in four segments: Refrigeration & Food Equipment, Fluids, Energy, and Engineered Systems.

General Dynamics (GD)

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Buy, PO $200

1Q investment thesis

General Dynamics is a defensive large cap value stock with potential cyclical growth. The company has a history of annual dividend increases with a dividend yield of 1.7%. Concerns about weakening demand for Gulfstream business jets in General Dynamic's Aerospace segment have weighed down sentiment. However, using a sum-of-the-parts analysis that values GD's defense businesses in line with the pure play defense average, this would imply that GD's Aerospace segment is trading at a significant discount to the market at 12x P/E multiple on 2018E earnings. Considering the strength in Gulfstream's product portfolio and margin performance, we would expect Aerospace to trade at least at 18x P/E multiple on 2018E earnings.

Table 1: General Dynamics key stock data

Industry	Aerospace & Defense
Market Cap (mn)	$57,215
Price	$173.21
P/E (2017)*	17.9x
% of sell-side rated Buy	76.2%
Short interest % of float	1.02%

Source: Bloomberg and BofA Merrill Lynch Global Research estimates

Gov't Legislation: 56% of sales are from the US government

General Dynamics' primary customer is the US Department of Defense, which accounted for 47% of total sales in 2015. The remaining 9% are to other non-DoD US government agencies like the intelligence community. For the military, which is a defensive sector, GD is engaged in engineering, manufacturing, and support of land and expeditionary combat vehicles and systems, armaments, munitions, and shipbuilding and marine systems. Major products include Virginia-class nuclear-powered submarine and Ohio class ballistic nuclear submarine replacement, Arleigh Burke-class Aegis destroyer, Abrams M1A2 tank, Stryker 8-wheeled assault vehicle, medium-caliber munitions and gun systems, tactical and strategic mission systems. The company also provides information systems and technologies.

Disruptor: Gulfstream G650 has unrivaled performance in the most profitable business jet market segment

There is no direct competitor aircraft currently in service in the market to match the performance of the Gulfstream G650/650ER. The G650ER has a range of 7,500 nautical miles at Mach 0.85, but can fly faster at Mach 0.90 with a range of 6,400 nautical miles. The Dassault Falcon 8X has a range of only 6,450 nautical miles. Meanwhile, Bombardier's response to the G650 has been delayed another year with the entry into service of the Global 7000 (range of 7,300 nautical miles) in 2H18. Gulfstream book-to-bill in 3Q16 was 1:1 on a dollar value basis and 1.2:1 on an aircraft unit basis. In our view, market share gains in a soft demand environment could provide Gulfstream a solid foundation to bridge the Gulfstream G450/550 to the G500/600.

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Catalysts: Stable Aerospace earnings & US defense spending
Operating weakness for Bombardier's Global family, which competes with the Gulfstream family, has weighed down investor sentiment for large cabin business jets and General Dynamics. However, Gulfstream's more conservative production rates, attractive product positioning, higher quality backlog, and better operating performance compared to Bombardier lower Gulfstream's near- and medium-term earnings risks, in our view. The key catalyst for General Dynamics is the upcoming earnings result that demonstrates how EBIT in the Aerospace segment remains stable despite a more tepid market outlook from Bombardier.

We continue to view GD as a beneficiary of positive inflection in US defense spending. We expect the recent Republican victory in the White House and the Senate to be seen as incrementally positive for defense. Political control is a key driver of defense spending, and defense stock valuations are tied to changes in defense spending related to the modernization accounts. Our Political Control Model (PCM) analysis highlights a Republican President and Republican Senate is the best case for Budget Authority in defense modernization accounts. Our PCM analysis suggests that the Republican sweep could increase the Budget Authority for defense investment accounts by a CAGR of 12-13% (FY17E-21E). This compares to the BofAML forecast of a 5% CAGR and the FY17 Green Book forecast of a 1% CAGR.

Additionally, GD's Marine Systems segment is a direct beneficiary of the US pivot to the Pacific. The Pacific is a hotbed of maritime activity particularly as China expands its territorial waters. As the US focus on naval superiority strengthens, we might see upside to shipbuilding spending.

Latest report: General Dynamics: Gulfstream still undervalued; raise PO to $200 and reiterate Buy 30 November 2016

1Q risks: large cabin business jets market deterioration and US defense spending
There is risk of market deterioration in large cabin business jets that could increase earnings risks for Gulfstream. Additionally, delays in government contracting or lower than expected increase in US defense spending could provide downside risks to our estimates.

Company Description
General Dynamics is a major US government contractor engaged in combat vehicles and systems, armaments, munitions, ordnance, shipbuilding and information systems and technologies. It is also the parent company of Gulfstream in its Aerospace segment, which is the most profitable airplane manufacturing company in the world.

Consolidated Edison (ED)

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Underperform, PO $59

1Q17 investment thesis
Since the November elections, utility valuations have not adequately adjusted to the rapid shift towards a rising-rate environment and have decoupled from historically predicative valuation patterns. Looking at studies of 10yr Yields v. Utility PEs, BBB Yields v. Utility PEs, and Utility Div. Yields v. Rates are the best examples of this

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dislocation (more metrics can be found in our Alternating Currents Weekly). We rate ED Underweight to take advantage of this sector dislocation. ED on its own is fundamentally overvalued. ED trades at a 0.5x premium to its peers despite having slower than average growth prospects, increasing regulatory complexity, and the overhanging risk of fines for the Harlem explosion.

Table 1: ConEd key stock data

Industry	US Electric Utilities
Market Cap (mn)	$22,400
Price	$74.07
Total Debt / 2019 EBITDA	3.88
% of sell-side rated Sell	26.3%
Short interest % of float	3.94%

Source: Bloomberg and BofA Merrill Lynch Global Research estimates

Not your grandmothers ConEd – increasing complexity changes investment story
ConEd is facing very slow growth electric demand growth in its utilities with 0.2% y/y growth in its CECONY subsidiary through 20201 and -0.1% growth in its O&R subsidiary. To offset this slow growth, ConEd has been increasing the complexity of its business by purchasing gas and electric transmission assets which have higher growth potential but face more market risk (most notably the JV with Crestwood in the Stagecoach midstream pipeline system). Furthermore, the regulatory regime in New York is undergoing a fundamental shift as the Reforming Energy Vision (REV) program is implemented. REV seeks to fundamentally change how utilities are compensated by creating more of a 'platform' for energy delivery. Slow growth, changing business mix, and new regulatory constructs add considerable risk to what used to be a "go to" vanilla regulated utility.

An overvalued Sector and Potential Catalysts
For a long time, ConEd was viewed as the quintessential utility and, during the run-up in Utility valuations in 2016 its shares outperformed despite its weakening fundamentals. As the story becomes more complex and the utility sector adjusts to lower valuation we would expect ED to underperform with a similar symmetry to other utility stocks.

Latest reports:

Recent BofA Merrill Lynch Global Research Reports

Title: Subtitle	Primary Author	Date Published
Utilities: Fed promises more hikes; utes face more downside risk in early 2017	Brian Chin	15 December 2016
Utilities: Alternating Currents Weekly	Brian Chin	18 December 2016

1Q17 risks: Risks to our thesis are primarily macro related. If utility sector valuations remain disconnected from historical fundamentals for the quarter or if rising interest rates significantly reverse course our Underweight rating on ConEd could not materialize.

Company Description: Consolidated Edison (ED) is the owner of Consolidated Edison Company of New York (CECONY) and Orange & Rockland Utilities (O&R) providing electric, gas and steam service to 3.5 million customers in New York City and the northern suburbs. ConEd also has a transmission segment with gas pipeline, storage, and electric transmission. Finally, ConEd has three competitive energy businesses: ConEd Development (energy infrastructure), Energy (wholesale services), and Solutions (retail services).

HOUSE_OVERSIGHT_014628

Hess Corporation (HES)

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Buy, PO $80

1Q17 investment thesis

Broad expectations of a pro-energy agenda from the incoming administration set a theoretically constructive backdrop for the US oils. Along with the tailwind from renewed OPEC support for oil prices, we view the broader energy sector as a momentum play in the early part of 2017 where stock specific catalysts can re-emerge to differentiate relative performance within the large cap US oils. We view Hess as the most catalyst rich large cap US E&P for 2017 with a return to growth and disproportionate exploration risk from a company with the highest cash margins in the sector, second best balance sheet and significant oil leverage to our base case that is an oil recovery in 2017. Hess remains amongst our top ideas in the US large cap oil sector for 2017, and we retain our Buy rating, and $80 PO.

Table 1: Hess key stock data

Industry	US oil and gas exploration and production
Market Cap (mn)	$19,090
Price	$62.90
EV/Debt adjusted cash flow (2017)*	9.4x
% of sell-side rated Buy	46.4%
Short interest % of float	8.52%

Source: Bloomberg and BofA Merrill Lynch Global Research estimates

Deregulation / Gov't Legislation

While the potential for a less onerous regulatory backdrop, and greater access to Federal lands for exploration and development, the majority of current activity remains dominated by private lands thereby limiting any material changes arising from a Republican administration. The exception is the potential for more receptive backdrop for infrastructure development that can improve regional pricing through improved access to takeaway capacity.

Tax Policy:

For the majority of the US E&P's, changes in corporate tax rates have negligible impact given that substantial net operating losses and deferred tax credits means that cash taxes remain *de minimis* for the foreseeable future.

Catalysts:

News flow starts with an expected capex budget unchanged from 2016 at ~$2bn, the company has stated it expects a return to drilling in the Bakken with a stated ramp up to 6 rigs from 2 currently returning the play to growth in 2017.. The first Guyana development (Liza) expected to achieve FID by 2Q17 and which we expect to confirm industry leading economics. Start-up of the first of two major developments – the North Malay basin gas play in 3Q17, putting Hess back on a growth track and turning attention to the Stampede start up in the US GoM in early 2Q18. In the background is an exploration test every 45-60 days any one of which could materially change the scale of the Hess business model of the next decade.

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Latest reports: Tales from the road (Dec 1, 2016); Speculation builds over Payara (Dec 19, 2016)

1Q17 risks: We expect a supportive commodity backdrop, spending clarity and confirmed return to growth all punctuated by a steady stream of large scale exploration news flow to support relative performance for Hess in 1Q17. Greatest risk to the broader energy sector comes from adherence of the OPEC agreement to support oil prices through coordinated production cuts; With this backdrop note that Hess retains one of the most resilient balance sheets in the sector, with adjusted net debt / cap of just 14% and $2.9bn of net cash on the balance sheet at end 3Q16.

Company Description: Hess Corp (HES) is a mid-sized oil & gas company with 1.0bn boe of proved reserves at end 2015. E&P operations are focused in the US onshore, deep water GOM, North Sea, Guyana, West Africa, and Asia.

MGM Resorts International (MGM)

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Buy, PO $33

1Q investment thesis

MGM is a levered play to improving/accelerating US economic growth. The US makes up 80% of EBITDA (70% Vegas, 20% Macau, 10% US regional) and the company has 4-5x net debt/EBITDA which is high, but coming down to under 4x by end of 2017 which could allow for a possible upgrade to investment grade by the end of 2017 or early 2018.

MGM has high operating leverage (50%+ flow through of revenues) and should benefit from any macroeconomic improvement as well as already healthy/strong Las Vegas fundamentals (visitation +3% YTD, RevPAR +6% which is one of best hotel markets in the US). MGM benefits from both consumer (80%) and business (20%) travel. There is zero supply growth in Las Vegas the next 2-3 years and virtually no Airbnb/disruption risk as staying at integrated casino resorts on the Strip is key to the experience.

MGM should see accelerating growth in 2017 to a very high +24% Y/Y on an organic basis. We think this is some of the highest growth we will see in the Gaming, Lodging & Leisure industries. MGM should also see a meaningful free cash flow inflection in 2017 as capex falls off dramatically after its 2 new property openings in Washington DC and Cotai/Macau.

Table 1: MGM key stock data

Industry	Gaming
Market Cap (mn)	$11,993
Price	$28.50
P/E (2017)	21.6x
% of sell-side rated Buy	95.7%
Short interest % of float	2.94%

Source: Bloomberg and BofA Merrill Lynch Global Research estimates

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Deregulation/Gov't Legislation: There aren't any clear/obvious changes here that would impact MGM. As a labor intensive business, changes to overtime rules or the Affordable Care Act as it relates to company level costs could be modestly beneficial.

Tax Policy: MGM will be a cash tax payer in 2017. Tax policy should be mixed. While they get some meaningful interest shield from their decent amount of debt, they also have relatively high capex that could benefit them if expensed as incurred. Import tariffs should be limited in impact as it's mostly a domestic, services based business with limited COGS.

Catalysts: ConAgg should generate RevPAR tailwinds. RevPAR should accelerate in Q1 and could be up double digits in the quarter driven by a strong convention calendar, headlined by the ConAgg convention which comes only once every 3 years.

MGM also opened its $1.4B National Harbor casino outside of Washington on December 8th. The first data points here on revenues will come in early January.

MGM's Cotai casino in Macau opens in 2Q17 and is a new $3B property. We believe expectations are reasonably low and revenues are still strong in Macau (+ double digits in 4Q). Despite recent softness, Macau peers still trade at premiums to core MGM

Latest report:
MGM Resorts International: Notes from the road: MGM National Harbor - the new standard for regionals

1Q risks: Macau sentiment has been fading recently as the RMB continues to depreciate and investors seek new growth opportunities domestically given the large cyclical rotations occurring in other sectors.

Company Description: MGM, is a global hotel and casino gaming company, owns and operates 19 properties located in NV, MD, MS, MI, IL and Macau. It owns a 50% stake in its CityCenter joint venture on the Las Vegas Strip and a 77% interest in MGM Growth Properties, a publicly traded gaming focused real estate investment trust (REIT).

Norfolk Southern (NSC)

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Buy, PO $122

1Q investment thesis

Norfolk Southern is benefiting from a volume inflection, with 9 consecutive weeks of carload growth year-over-year, after nearly 2 years of sustained negative carload declines. Aside from the ongoing inflection in data, the company should benefit in 2017 from its own structural efficiency program and many potential macro shifts currently under President-elect Trump's Administration. The new management team (Jim Squires was named CEO in 2015) is working to change the culture and business processes, and has delivered for a few quarters. It set operating targets for the first time in company history, targeting $650 million in efficiency gains (+25% to 2015 EPS) and a 65% operating ratio by 2020. It also set $250 million in efficiency gains and a sub-70% operating ratio in 2016, allowing it to immediate progress. In January, management has noted it will further detail its efficiency gain targets, which could be a near-term catalyst for the shares. Under Trump's proposal's, NS could benefit from a lower tax

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rate, given its 37% current effective tax rate (at 30% adds $10 to valuation and at 20% adds $25 to valuation), as well as additional infrastructure spend (more aggregates, cement, rebar, etc...), focus on domestic manufacturing, and repatriation of capital, which could aid GDP growth. We target NSC to post sustained double-digit EPS growth and significantly improve free cash flow.

Table 1: Norfolk Southern key stock data

Industry	Railroad
Market Cap (mn)	$33,393
Price	$108.82
P/E (2017)	17.3x
% of sell-side rated Buy	44.8%
Short interest % of float	1.19%

Source: Bloomberg and BofA Merrill Lynch Global Research estimates

Deregulation/Gov't Legislation:
The Surface Transportation Board, an independent governing body, formerly under the Department of Transportation, is set for a significant turnover, with a Republican taking control of the chairmanship, and 2 new members being added to the 5-person Board (up to this year the STB was a 3 member Board). The potential for negative impacts from mandatory open access and rate of return calculation adjustments may be reduced given the change of administration, which would be a positive for the railroad group.

Tax Policy:
Given their domestic focus, Transportation companies are the highest effective tax payers in the Industrial and Basic Materials group, with the U.S.-based railroads averaging a 37% effective tax rate. At a 20% tax-rate, EPS would jump nearly 30% (though full capex expensing could reduce EBIT to offset a sizeable portion of the gain). Additionally, cross-border tax increasing cost of goods sold for manufacturing goods could slow GDP, impacting carload growth over time.

Catalysts:
Near term catalysts include accelerating carload growth, coal turning positive for the rail industry this week, after 90 consecutive down weeks, and NS's upcoming January promise for additional details on its targeted efficiency gains. The company is set to post a sub-70% operating ratio for only the 2nd time in the past 20 years, a target we would expect to improve further in 2017 and beyond.

Latest report: Raise estimates and PO to $122; Volumes trending above target
October Upgrade report: Time to look at things differently; Raise to Buy

1Q risks: Norfolk Southern has posted 9 consecutive weeks of carload growth, indicating underlying economic growth, with relatively easy comps into 1H17. Thus, risk includes carload growth slowing or turning back negative, as well as increased concern on macro GDP growth rates given fear about new fiscal policies (cross-border tax, full capex expensing) which could compress EPS. Additionally, if the expected discussion on efficiency gain details in January is not provided as expected, investors could lose confidence that management will stick with and/or meet its 2020 target. Additionally, if corporate tax reform is not passed, multiples that have expanded on some reduced tax rate could re-compress.

Company Description: Norfolk Southern Railway operates a 21,300 route mile railroad network in 22 eastern states, District of Columbia, and Ontario, Canada. We target it to generate $10 billion in 2016 revenues and a sub-70% operating ratio (hitting that target

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for only the 2nd time in the past 20 years). We target it to move 7.22 million carloads in 2016, with an average revenue per car of $1,371. Coal represents 14% of total revenues, down from 36% 2 years prior. Intermodal represents 22% of revenues, and Ag/Consumer/Gov't represents 16% of revenues.

SVB Financial Group (SIVB)

Ebrahim H. Poonawala +1 646 743 0490
Research Analyst, MLPF&S

Buy, PO $190

1Q investment thesis

We view SIVB as the best positioned bank in our coverage universe by a wide margin to benefit from the combination of **1)** rising interest rates – with SIVB ranking among the most rate sensitive banks in the mid-cap banks group **2)** stronger economic growth - with SIVB's 2017 guidance (issued before the US elections) already calling for double digit revenue growth **3)** de-regulation **4)** tax reform. Our '17e EPS of $9 and '18e EPS of $12 imply YoY EPS growth of 24% and 33% respectively. SIVB trades at 18x our '17e EPS and 2x YE17e TBV. Our PO of $190 implies P/'17e EPS of 20x (and 16x '18e EPS) and P/YE17e TBV of 2.4x. This compares to an average P/E of 22.7x and P/TBV of 2.6x that the stock traded at heading into and during the initial stages of the 2004-2006 interest rate cycle.

Table 1: SIVB key stock data

Industry	Commercial Banks
Market Cap (mn)	$8,584
Price	$170.38
P/E (2017)	19.1x
% of sell-side rated Buy	77.8%
Short interest % of float	4.68%

Source: Bloomberg and BofA Merrill Lynch Global Research estimates

Deregulation/Gov't Legislation: Among the one legislative action on the regulatory front that appears likely to be passed under the new administration is the increase in the $50bn SIFI asset threshold which brings with a heightened level of regulatory scrutiny (such as undergoing the CCAR stress test). While we were not concerned about SIVB's ability to transition into a CCAR bank, the removal of this should no doubt serve as a positive. At $43bn in assets, becoming a CCAR bank had been weighing on investor sentiment. With expectations for this threshold to be pushed higher, this should no longer be a significant concern when thinking about SIVB's growth trajectory. Another issue that has not been discussed much but could occur is any changes in the Volcker rule that would allow the bank to once again participate in investing capital in PE/VC funds. We view this restriction as an unintended consequence on SIVB stemming from the Volcker rule and the ability once again participate in these funds would be a significant positive given the potential for getting equity exposure in the early stages of the life cycle of start-up companies.

Tax Policy: With SIVB paying an effective tax rate of 40.6% in 2016 YTD, the bank will undoubtedly be a beneficiary from a lower corporate tax rate. While we believe it is too soon to adjust estimates for this, we note that a 500bp reduction in the tax rate would equate to 8.4% upside to SIVB's 2018 EPS estimate. Moreover, the potential for hundreds of billion dollars in tax repatriation by the US tech giants also augurs well for greasing the wheels for the start-up sector. While some of this repatriated capital will no doubt go to buy backs and higher dividends, we expect some of this to flow into the start-up space as tech giants pursue M&A. At the very least it mitigates the risk of any

Bank of America Merrill Lynch

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significant credit issues for the banks as weaker firms (who are clients) will be better positioned to sell themselves to the tech behemoths looking for innovative ideas.

Catalysts: 1) Improving expectations around rising rates (on back of better macro-economic data) will continue to serve as a tailwind for the stock 2) A strong tech IPO market – as SIVB stands to benefit from equity exposure to 1000+ start-up companies 3) Clarity around a tax reform bill once the new administration takes office in January should lead to the markets pricing-in a lift to forward EPS and 4) updated 2017 guidance could reflect a stronger outlook vs. management's preliminary guidance provided in Oct 2016.

Latest report: On its way to regaining its premium multiple

1Q risks: Downside risks are 1) reversal in the outlook for higher rates 2) a sharp sell-off in the equity markets that could derail IPO activity and 3) disappointment on the pace of policy actions under the new administration.

Company Description: SVB Financial Group is a financial holding company that serves companies in the technology, life science, venture capital, private equity and premium wine industries. The bank offers diversified financial services such as commercial, investment, international and private banking. Headquartered in Santa Clara, California, SVB Financial Group (Nasdaq: SIVB) operates through offices in the U.S. and international operations in China, India, Israel and the United Kingdom.

Texas Instruments (TXN)

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Research Analyst, MLPF&S

Buy, PO $82

1Q investment thesis

In the aftermath of the US election in November, we think Texas Instruments stands to benefit the most with its 30% effective tax rate and high exposure to industrial, automotive, automation, and communications capex. The company has been one of the largest share gainers in industrial/auto semis entering a seasonally strong period for spending. Unlike peers, Texas instruments has no distraction from M&A while maintaining a grossly under-levered balance sheet (<0.1x net debt/EBITDA vs comps at 2x-4x). We expect TXN to continue to generate industry leading FCF while growing its dividend at 20%+ CAGR. We look toward the strategy update call in early February as the next catalyst for the stock.

Table 1: Texas Instruments key stock data

Industry	Semiconductors
Market Cap (mn)	$73,899
Price	$74.15
P/E (2017)	20.1x
% of sell-side rated Buy	35.3%
Short interest % of float	1.75%

Source: Bloomberg and BofA Merrill Lynch Global Research estimates

Deregulation/Gov't Legislation: 60% of TXN's sales are exposed to the industrial, automotive, and communications equipment end markets. We think these markets could

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see the most uplift in spending from any potentially large fiscal stimulus and infrastructure spending under the new US administration.

Tax Policy: Unlike most semis, TXN reports its financials on a pure GAAP basis and its tax rate at 30% is one of the highest in the industry. We think TXN stands to disproportionately benefit from the looser tax policies foreshadowed by the upcoming administration. Specifically, a 10% drop in the corporate tax rate would lead to 15% higher EPS for TXN in 2017, all else equal.

Catalysts: (1) Seasonally stronger period for industrial/automotive spending – 46% of TXN's revenue come from these end markets; (2) Annual strategy and capital allocation policy update call with shareholders which is likely to occur at the beginning of February.

Latest report: The new "industrials": growth recovery plus pricing power, Buy TXN, ADI, MCHP, ON

1Q risks: (1) Still somewhat large (>10%) exposure to consumer electronics could create near-term volatility in topline results; (2) Historically lumpy communications equipment spending trends; (3) Larger than expected slowdown in North America automotive unit production

Company Description: Texas Instruments is a broad-based supplier of semiconductor components, ranging from digital signal processors, to high-performance analog components, to digital light-processing technology and calculators. 65% of TXN sales are exposed to the well diversified, business-to-business Industrial, Automotive, Communications Infrastructure, and Enterprise markets.

TripAdvisor (TRIP)

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Research Analyst, MLPF&S

Underperform, PO $41

1Q investment thesis

Despite easier y/y comps in 2017, we see risk that Click-based & Transaction Hotel revenue continues to decline as 1) higher monetizing desktop traffic structurally declines, 2) mobile monetization remains at 30% of desktop traffic and is unlikely to meaningfully close the gap, and 3) Instant Book is unlikely to help reverse the revenue and earnings trend. At the same time, TRIP has been accelerating marketing spend, implying increasing acquisition costs, with further ad spend ramp in '17. TRIP noted 2017 EBITDA margin will decline further from 2016 levels as ad spend ticks up to re-accelerate growth.

Table 1: TripAdvisor key stock data

Industry	Online Travel
Market Cap (mn)	$9,071
Price	$46.95
P/E (2017)	32.5x
% of sell-side rated Buy	14.3%
Short interest % of float	10.30%

Source: Bloomberg and BofA Merrill Lynch Global Research estimates

Bank of America Merrill Lynch

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Tax Policy: TRIP has a ~25% tax rate. Trump's tax plan calls for a reduction in the business tax rate from 35% to 15%, with elimination of most corporate tax deductions/credits (except for the R&D credit). While it's unclear what elements of the tax plan will eventually be executed, Trump's intent is clear and we believe companies with the highest tax rate have the most to gain. We see less incremental benefit to many of the global companies who already enjoy optimized tax rates (22% average tax rate across our coverage), but many companies will have more incentive to bring back Intl profits for buybacks with lower US tax rates.

Catalysts: 4Q'16 Earnings (early February) will feature initial 2017 guidance. TripAdvisor noted on the 3Q'16 earnings call that 2017 EBITDA margin will decline further from 2016 levels as ad spend ticks up to re-accelerate growth, however it is unclear how much margin deterioration TripAdvisor will guide to. We think the deterioration in the guide will be higher than the Street's expectations, driving further downside estimate revisions.

Latest report: TripAdvisor: 2017 PM Level Outlook

1Q risks: There is downside risk to Street estimates if hotel shopper growth comes in below expectations, mobile monetization gap widens, and if initial 2017 guidance disappoints. We remain cautious on IB as an attempt to solve a very large problem: the continued transition of users consuming TripAdvisor's content on their mobile phones instead of their desktops. On mobile phones, users are much less likely to transact or click on an ad than on desktops.

A risk to the short thesis: There has been frequent speculation in the press that TripAdvisor may be a takeout candidate in the rapidly consolidating online travel market, with Priceline frequently named as the likely suitor.

Company Description: TripAdvisor is the largest global online travel media company with over millions of members and hundreds of millions of user reviews. The company's portfolio of web properties attracts over 300 million unique visitors per month worldwide.

Price objective basis & risk

Aetna Inc (AET)
Our Price Objective of $149 is based on a 50/50 blend of our standalone AET valuation ($138, 13.1x 2018E EPS of $10.50 when including share repurchase) and AET pro forma HUM valuation ($160, 14x 2018E EPS of $11.40). Our AET standalone valuation multiple reflects AET's historical average discount to the S&P 500. Our AET pro forma HUM valuation multiple of 14x reflects upside levers to HUM synergy guidance and to reflect the improved long-term growth profile of the company. Risks to the upside are regulatory approval of the HUM acquisition, better-than-expected membership growth and lower than expected cost trend. Risks to the downside are regulators not approving the HUM acquisition, lower-than-expected membership growth and higher than expected cost trend.

Consolidated Edison (ED)
Our price objective of $59 is predicated on shares of ED achieving 13.0x our 2019 EPS estimate. We apply the current group average multiple of 13.5x and apply a 0.5x discount to reflect a well below average ROE, a slightly below average growth profile, and a relatively challenging regulatory environment. This is offset slightly by a lower risk

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profile investment outlook. Upside risks to our thesis could stem from more favorable changes to the investment and/or regulatory environment in New York.

Downside/upside risks: ED, like all utility stocks, is also sensitive to changes in the market level of interest rates. Utilities historically underperform if bond yields rise, and outperform when they fall. Furthermore, ED is a bellwether utility and has historically outperformed during market uncertainty as a large liquid "flight to safety" stock.

Dover Corp (DOV)
Our PO of $85 is based on 11.5x EV/EBITDA on our 2017 estimate, which would put DOV in line with the multi-industrial peer group average. We view the target multiple as conservative, as we expect the Street to focus on EPS growth upside in '17, driven by Energy coming off depressed profitability.

Risks to our PO are: 1) Highly dependent on acquisition strategy, 2) A reduction in capital spending in the oil & gas market, and 3) Weak global industrial production growth.

General Dynamics (GD)
We derive our PO of $200 using a sum-of-the-parts valuation model. Our model factors in 19.5x P/E multiple on 2018E earnings for GD's defense business, which is in line with pure play defense peers, and 18x P/E multiple on Gulfstream's 2018E earnings. In our view, GD's competitive business jet product portfolio and growth outlook in defense could provide near-term and medium-term organic growth. Additionally, the company's strong balance sheet and solid cash generation could sustain dividend growth and share repurchases.

Downside risks to our PO are: 1) A downturn in business jets, due to an exogenous factor. 2) Given that business jets are priced in dollars, an unexpected devaluation in the dollar could significantly impact order activity, 3) We are forecasting a declining defense budget, which would then place a cap on the top-line growth for the defense primes. We view the Administration change as a potential ceiling to defense stocks as political control, in our view, is a key driver of defense spending. Decline in defense spending authorization (a leading indicator), which in turn could impact treasury outlays. Potential budget cuts to the Navy's fleet could encumber GD as well as a slowdown in procurement for the Army (armored vehicles). 4) Poor execution on defense programs could adversely impact margins.

Hess Corp. (HES)
Our price objective of $80 / share is based on a 5-year outlook which assumes a 5.5x DACF multiple and a commodity deck of $67.50 WTI and $70 Brent to which we add $10 / sh for Liza in offshore Guyana. The multiple is based on a finite timeline to delivery which is supported by core NAV.

The risks to our price objective are: 1) the oil and gas price environment, (2) slowdowns in development drilling that leave production below expectations, and (3) news flow around HES' exploratory and appraisal drilling activities that could impact the stock.

MGM Resorts International (MGM)
Our $33 PO is based on 11.5x our 2017 EBITDA estimate (implied 10x 2018E EBITDA). This is in line with its historical trading range and supported by our detailed sum of the parts analysis.

Upside risks are: a stronger than anticipated recovery in Las Vegas, improving consumer sentiment and its 56% ownership stake in MGM China. Downside risks are: balance sheet and liquidity risks proving worse than expected, continued Strip competition, and continuing near-term softness in the Macau market.

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Norfolk Southern (NSC)
Our $122 price objective is based on a 19.5x multiple on our 2017 EPS estimate of $6.25. We move above the top of its one-standard deviation historical trading range of 12x-16x given the new management team's move to improve margins, cut costs, and raise its ROIC, and as EPS inflects off a volume deflated 19% decline in 2015.

Risks to our price objective and estimates are the company's ability to derive continued operational benefits, a return to significant pricing competition among the rails, slower than expected economic growth, a deterioration to improving service metrics, a heavily unionized employee base, inability to exercise pricing power due to regulatory changes or legal challenges from customers, external factors (such as weather) impacting operations, and the STB installing mandatory reciprocal switching (or open access) to the rail network without proper pricing.

SVB Financial Group (SIVB)
We use a three-factor valuation framework (P/TBV, P/E, DCF) to arrive at our $190 price objective and assign a 2.3x multiple to our 2017e TBV and apply a 21x P/E to 17E EPS. Our valuation multiples are both in line with high growth peers due to SIVB's high profitability and EPS growth profile. Our DCF assumes a two-stage cost of capital of 9.5% and a terminal growth rate of 6%.

Downside risks are a longer than expected low rate environment and a slowdown in the technology sector and related IPO activity. Upside risks are sooner than expected rate hike, or better than expected pickup in the tech sector.

Texas Instruments Inc. (TXN)
Our $82 PO on TXN is based on14x FY17E EV/EBITDA, in line with high quality diversified and analog peers trading at 14x-15x, given TXN's high quality business model and strong FCF generation.

Risks to our price objective: 1) Lumpy telco capex, especially in wireless deployments, 2) Volatile market share as design cycle times are very long, 3) Increased R&D spending pressure to maintain an edge versus the competition, 4) Inventory cycles and potential double ordering by customers that can often create mismatches between real supply and demand, 5) Exposure to several mature markets such as PC and other consumer electronics could limit its growth rate.

TripAdvisor (TRIP)
Our price objective of $41 is based on 21x our 2018 non-GAAP EPS estimate. This multiple represents a premium to online travel/vertical media comps and in our view adequately compensates TripAdvisor for improving margins and growth off a trough point in FY16 into FY17 when the negative impacts of its IB transition peak.

Downside risks to our price objective are: 1) increasing competition (e.g. Yelp), 2) macro-economic factors (e.g. recession in Europe) impacting the travel industry, 3) challenges to the credibility of online reviews, 4) Instant Book transition puts pressure on revenue growth, and 5) mobile monetization headwinds.

Upside risks to our price objective are: 1) improved mobile monetization 2) major OTA sign on for instant booking 3) high non-hotel shopper dollar capture and 4) improved global macro environment.

Analyst Certification

We, Derek Harris, Andrew Obin, Brian Chin, Doug Leggate, Ebrahim H. Poonawala, Ken Hoexter, Kevin Fischbeck, CFA, Nat Schindler, Ronald J. Epstein, Shaun C. Kelley and Vivek Arya, hereby certify that the views each of us has expressed in this research report

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accurately reflect each of our respective personal views about the subject securities and issuers. We also certify that no part of our respective compensation was, is, or will be, directly or indirectly, related to the specific recommendations or view expressed in this research report.

HOUSE_OVERSIGHT_014639

US - Aerospace and Defense Coverage Cluster

Investment rating	Company	BofA Merrill Lynch ticker	Bloomberg symbol	Analyst
BUY				
	AerCap Holdings N.V.	AER	AER US	Kristine T. Liwag
	Air Lease Corporation	AL	AL US	Kristine T. Liwag
	Bombardier Inc.	YBBD B	BBD/B CN	Ronald J. Epstein
	Booz Allen Hamilton	BAH	BAH US	Ronald J. Epstein
	CAE Inc.	YCAE	CAE CN	Ronald J. Epstein
	Embraer	ERJ	ERJ US	Ronald J. Epstein
	General Dynamics	GD	GD US	Ronald J. Epstein
	Lockheed Martin	LMT	LMT US	Ronald J. Epstein
	Northrop Grumman	NOC	NOC US	Ronald J. Epstein
	Raytheon Co.	RTN	RTN US	Ronald J. Epstein
	RBC Bearings Inc	ROLL	ROLL US	Kristine T. Liwag
	Textron	TXT	TXT US	Ronald J. Epstein
	TransDigm Group Inc.	TDG	TDG US	Ronald J. Epstein
	Triumph Group	TGI	TGI US	Ronald J. Epstein
	United Tech	UTX	UTX US	Ronald J. Epstein
NEUTRAL				
	BWX Technologies, Inc.	BWXT	BWXT US	Ronald J. Epstein
	Crane Co	CR	CR US	Kristine T. Liwag
	Curtiss-Wright Corporation	CW	CW US	Kristine T. Liwag
	FLY Leasing Ltd	FLY	FLY US	Kristine T. Liwag
	HEICO Corporation	HEI	HEI US	Ronald J. Epstein
	Hexcel Corporation	HXL	HXL US	Ronald J. Epstein
	Huntington Ingalls Industries	HII	HII US	Ronald J. Epstein
	L-3 Comm	LLL	LLL US	Ronald J. Epstein
	Mercury Systems	MRCY	MRCY US	Ronald J. Epstein
	Rockwell Collins	COL	COL US	Ronald J. Epstein
	Spirit AeroSys-A	SPR	SPR US	Ronald J. Epstein
UNDERPERFORM				
	Aircastle LTD	AYR	AYR US	Kristine T. Liwag
	Boeing	BA	BA US	Ronald J. Epstein
	Esterline Technologies Corporation	ESL	ESL US	Ronald J. Epstein
	Garmin	GRMN	GRMN US	Ronald J. Epstein
	Moog Inc.	MOGA	MOG/A US	Kristine T. Liwag
	Wesco Aircraft Holdings, Inc	WAIR	WAIR US	Ronald J. Epstein

HOUSE_OVERSIGHT_014640

US - Electric Utilities Coverage Cluster

Investment rating	Company	BofA Merrill Lynch ticker	Bloomberg symbol	Analyst
BUY				
	American Electric Power	AEP	AEP US	Brian Chin
	American Water Works	AWK	AWK US	Brian Chin
	Black Hills Corporation	BKH	BKH US	Brian Chin
	Dominion Resources	D	D US	Brian Chin
	DTE Energy	DTE	DTE US	Brian Chin
	Edison International	EIX	EIX US	Brian Chin
	FirstEnergy	FE	FE US	Brian Chin
	Great Plains Energy	GXP	GXP US	Brian Chin
	NextEra Energy	NEE	NEE US	Brian Chin
	NextEra Energy Partners	NEP	NEP US	Brian Chin
	PG&E Corporation	PCG	PCG US	Brian Chin
NEUTRAL				
	Calpine	CPN	CPN US	Brian Chin
	Exelon	EXC	EXC US	Brian Chin
	InfraREIT, Inc.	HIFR	HIFR US	Brian Chin
	NRG Energy	NRG	NRG US	Brian Chin
	Pinnacle West Corp	PNW	PNW US	Brian Chin
	PPL Corporation	PPL	PPL US	Brian Chin
UNDERPERFORM				
	AES Corporation	AES	AES US	Brian Chin
	Consolidated Edison	ED	ED US	Brian Chin
	Duke Energy	DUK	DUK US	Brian Chin
	Entergy	ETR	ETR US	Brian Chin
	NorthWestern Corporation	NWE	NWE US	Brian Chin
	Portland General Electric Company	POR	POR US	Brian Chin
	Public Service Enterprise Group Inc.	PEG	PEG US	Brian Chin
	Southern Company	SO	SO US	Brian Chin

HOUSE_OVERSIGHT_014641

US - Internet Coverage Cluster

Investment rating	Company	BofA Merrill Lynch ticker	Bloomberg symbol	Analyst
BUY				
	Alphabet	GOOGL	GOOGL US	Justin Post
	Alphabet	GOOG	GOOG US	Justin Post
	Amazon.com	AMZN	AMZN US	Justin Post
	Bankrate	RATE	RATE US	Nat Schindler
	eBay	EBAY	EBAY US	Justin Post
	Expedia	EXPE	EXPE US	Justin Post
	Facebook	FB	FB US	Justin Post
	GrubHub	GRUB	GRUB US	Nat Schindler
	IAC InterActive	IAC	IAC US	Nat Schindler
	LendingTree	TREE	TREE US	Nat Schindler
	Match Group	MTCH	MTCH US	Nat Schindler
	Netflix, Inc.	NFLX	NFLX US	Nat Schindler
	OnDeck Capital	ONDK	ONDK US	Nat Schindler
	priceline.com	PCLN	PCLN US	Justin Post
	Take-Two Interactive	TTWO	TTWO US	Justin Post
	Wix.com	WIX	WIX US	Nat Schindler
	Yahoo!	YHOO	YHOO US	Justin Post
	Zillow	ZG	ZG US	Nat Schindler
	Zillow	Z	Z US	Nat Schindler
NEUTRAL				
	Activision	ATVI	ATVI US	Justin Post
	Electronic Arts	EA	EA US	Justin Post
	Quotient Technology Inc	QUOT	QUOT US	Nat Schindler
	Wayfair	W	W US	Justin Post
	Yelp	YELP	YELP US	Justin Post
UNDERPERFORM				
	Care.com	CRCM	CRCM US	Justin Post
	Fitbit	FIT	FIT US	Nat Schindler
	GoPro	GPRO	GPRO US	Jason Mitchell
	Pandora Media, Inc.	P	P US	Nat Schindler
	TripAdvisor	TRIP	TRIP US	Nat Schindler
	Twitter	TWTR	TWTR US	Justin Post
	ZYNGA	ZNGA	ZNGA US	Justin Post
RVW				
	Chegg	CHGG	CHGG US	Nat Schindler

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US - Multi-Industrials/Engineering and Construction Coverage Cluster

Investment rating	Company	BofA Merrill Lynch ticker	Bloomberg symbol	Analyst
BUY				
	3M Company	MMM	MMM US	Andrew Obin
	AECOM	ACM	ACM US	Anna Kaminskaya, CFA
	Allegion	ALLE	ALLE US	Andrew Obin
	AMETEK Inc	AME	AME US	Andrew Obin
	Colfax Corporation	CFX	CFX US	Andrew Obin
	Dover Corp	DOV	DOV US	Andrew Obin
	Fortive Corporation	FTV	FTV US	Andrew Obin
	General Electric Company	GE	GE US	Andrew Obin
	HD Supply Holdings Inc	HDS	HDS US	Andrew Obin
	Honeywell International Inc.	HON	HON US	Andrew Obin
	Ingersoll-Rand	IR	IR US	Andrew Obin
	KBR	KBR	KBR US	Anna Kaminskaya, CFA
	Milacron	MCRN	MCRN US	Andrew Obin
	Mistras Group	MG	MG US	Andrew Obin
	Rush	RUSHA	RUSHA US	Andrew Obin
NEUTRAL				
	Eaton Corp PLC	ETN	ETN US	Andrew Obin
	Flowserve	FLS	FLS US	Andrew Obin
	ITT Inc.	ITT	ITT US	Andrew Obin
	Jacobs Eng.	JEC	JEC US	Anna Kaminskaya, CFA
	Parker Hannifin Corporation	PH	PH US	Andrew Obin
UNDERPERFORM				
	Chicago Bridge & Iron Company	CBI	CBI US	Anna Kaminskaya, CFA
	Donaldson Co	DCI	DCI US	Andrew Obin
	Emerson Electric Co	EMR	EMR US	Andrew Obin
	Fluor Corp	FLR	FLR US	Anna Kaminskaya, CFA
	Pentair plc	PNR	PNR US	Andrew Obin
	Rexnord Corporation	RXN	RXN US	Andrew Obin
	Rockwell	ROK	ROK US	Andrew Obin
	SPX Flow Inc.	FLOW	FLOW US	Andrew Obin

US - Semiconductors Coverage Cluster

Investment rating	Company	BofA Merrill Lynch ticker	Bloomberg symbol	Analyst
BUY				
	Advanced Micro Devices, Inc	AMD	AMD US	Vivek Arya
	Analog Devices Inc.	ADI	ADI US	Vivek Arya
	Broadcom Limited	AVGO	AVGO US	Vivek Arya
	Cypress	CY	CY US	Vivek Arya
	Inphi Corporation	IPHI	IPHI US	Vivek Arya
	Integrated Device Technology, Inc.	IDTI	IDTI US	Vivek Arya
	Intel	INTC	INTC US	Vivek Arya
	Microchip	MCHP	MCHP US	Vivek Arya
	NVIDIA Corporation	NVDA	NVDA US	Vivek Arya
	ON Semiconductor	ON	ON US	Vivek Arya
	Skyworks Solutions, Inc.	SWKS	SWKS US	Vivek Arya
	Texas Instruments Inc.	TXN	TXN US	Vivek Arya
NEUTRAL				
	Cavium	CAVM	CAVM US	Vivek Arya
	M/A-Com	MTSI	MTSI US	Vivek Arya
	Maxim Integrated Products Inc.	MXIM	MXIM US	Vivek Arya
UNDERPERFORM				
	Marvell Technology Group Ltd.	MRVL	MRVL US	Vivek Arya
	Qorvo Inc.	QRVO	QRVO US	Vivek Arya
	Xilinx Inc.	XLNX	XLNX US	Vivek Arya

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US - Transportation Coverage Cluster

Investment rating	Company	BofA Merrill Lynch ticker	Bloomberg symbol	Analyst
BUY				
	Canadian Pacific Railway	CP	CP US	Ken Hoexter
	CSX Corporation	CSX	CSX US	Ken Hoexter
	FedEx Corp.	FDX	FDX US	Ken Hoexter
	Fortress Transportation & Infrastructure	FTAI	FTAI US	Ariel Rosa
	Golar LNG Limited	GLNG	GLNG US	Ken Hoexter
	Golar LNG Partners LP	GMLP	GMLP US	Ken Hoexter
	Hoegh LNG Partners LP	HMLP	HMLP US	Ken Hoexter
	J.B. Hunt Transport Services	JBHT	JBHT US	Ken Hoexter
	Norfolk Southern	NSC	NSC US	Ken Hoexter
	Scorpio Tankers Inc.	STNG	STNG US	Ken Hoexter
	Swift Transportation	SWFT	SWFT US	Ken Hoexter
	Triton International, Ltd	TRTN	TRTN US	Ken Hoexter
	Union Pacific	UNP	UNP US	Ken Hoexter
	UPS	UPS	UPS US	Ken Hoexter
NEUTRAL				
	ArcBest Corporation	ARCB	ARCB US	Ken Hoexter
	Genesee & Wyoming	GWR	GWR US	Ken Hoexter
	Kansas City Southern	KSU	KSU US	Ken Hoexter
	Knight Transport	KNX	KNX US	Ken Hoexter
	Navios Maritime Midstream Partners L.P.	NAP	NAP US	Ken Hoexter
	The Greenbrier Companies	GBX	GBX US	Ken Hoexter
	World Fuel Services	INT	INT US	Ken Hoexter
UNDERPERFORM				
	C.H. Robinson	CHRW	CHRW US	Ken Hoexter
	Canadian National	CNI	CNI US	Ken Hoexter
	Kirby Corp	KEX	KEX US	Ken Hoexter
	Old Dominion Freight Line	ODFL	ODFL US	Ariel Rosa
	Seaspan Corp	SSW	SSW US	Ken Hoexter
	Teekay Tankers Limited	TNK	TNK US	Ken Hoexter
	Werner Enterprises	WERN	WERN US	Ken Hoexter

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US - Large Cap Oils Coverage Cluster

Investment rating	Company	BofA Merrill Lynch ticker	Bloomberg symbol	Analyst
BUY				
	Anadarko Petroleum Corp.	APC	APC US	Doug Leggate
	Cabot Oil & Gas Corp.	COG	COG US	Doug Leggate
	ConocoPhillips	COP	COP US	Doug Leggate
	Continental Resources Inc.	CLR	CLR US	Doug Leggate
	Devon Energy Corp.	DVN	DVN US	Doug Leggate
	Hess Corp.	HES	HES US	Doug Leggate
	Marathon Oil Corp.	MRO	MRO US	Doug Leggate
	Marathon Petroleum Company	MPC	MPC US	Doug Leggate
	Occidental Petroleum Corp.	OXY	OXY US	Doug Leggate
	Pioneer Natural Resources	PXD	PXD US	Doug Leggate
	Range Resources Corp	RRC	RRC US	Doug Leggate
	Tesoro Corp.	TSO	TSO US	Doug Leggate
NEUTRAL				
	Chesapeake Energy Corp.	CHK	CHK US	Doug Leggate
	Chevron Corp.	CVX	CVX US	Doug Leggate
	EOG Resources	EOG	EOG US	Doug Leggate
	ExxonMobil Corp.	XOM	XOM US	Doug Leggate
	HollyFrontier Corp	HFC	HFC US	Doug Leggate
	Noble Energy	NBL	NBL US	Doug Leggate
	Phillips 66	PSX	PSX US	Doug Leggate
	Southwestern Energy Corp.	SWN	SWN US	Doug Leggate
	Valero Energy Corp.	VLO	VLO US	Doug Leggate
UNDERPERFORM				
	Apache Corp	APA	APA US	Doug Leggate
	Calumet Specialty Products Partners	CLMT	CLMT US	Jason Smith
	Delek US Holdings, Inc.	DK	DK US	Doug Leggate
	PBF Energy	PBF	PBF US	Doug Leggate

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US - Facilities, Hospitals and Managed Healthcare Coverage Cluster

Investment rating	Company	BofA Merrill Lynch ticker	Bloomberg symbol	Analyst
BUY				
	Acadia Healthcare	ACHC	ACHC US	Kevin Fischbeck, CFA
	Aetna Inc	AET	AET US	Kevin Fischbeck, CFA
	American Renal	ARA	ARA US	Kevin Fischbeck, CFA
	Anthem	ANTM	ANTM US	Kevin Fischbeck, CFA
	Capital Senior Living	CSU	CSU US	Joanna Gajuk
	Centene Corporation	CNC	CNC US	Kevin Fischbeck, CFA
	Civitas Solutions	CIVI	CIVI US	Kevin Fischbeck, CFA
	Envision Healthcare Corp	EVHC	EVHC US	Kevin Fischbeck, CFA
	HCA	HCA	HCA US	Kevin Fischbeck, CFA
	Mednax	MD	MD US	Kevin Fischbeck, CFA
	Service Corp. International	SCI	SCI US	Joanna Gajuk
	Surgery Partners, Inc	SGRY	SGRY US	Kevin Fischbeck, CFA
	Surgical Care Affiliates, Inc.	SCAI	SCAI US	Kevin Fischbeck, CFA
	UnitedHealth Group	UNH	UNH US	Kevin Fischbeck, CFA
NEUTRAL				
	DaVita Inc	DVA	DVA US	Kevin Fischbeck, CFA
	Tenet Healthcare	THC	THC US	Kevin Fischbeck, CFA
	Universal Health Services	UHS	UHS US	Kevin Fischbeck, CFA
	WellCare Health Plans, Inc.	WCG	WCG US	Kevin Fischbeck, CFA
UNDERPERFORM				
	Adeptus	ADPT	ADPT US	Kevin Fischbeck, CFA
	Brookdale Senior Living	BKD	BKD US	Joanna Gajuk
	Community Health Systems	CYH	CYH US	Kevin Fischbeck, CFA
	Genesis Healthcare Inc	GEN	GEN US	Joanna Gajuk
	HealthSouth	HLS	HLS US	Kevin Fischbeck, CFA
	Kindred Healthcare	KND	KND US	Kevin Fischbeck, CFA
	LifePoint Health	LPNT	LPNT US	Kevin Fischbeck, CFA
	Molina Healthcare, Inc.	MOH	MOH US	Kevin Fischbeck, CFA
	Select Medical Corp.	SEM	SEM US	Kevin Fischbeck, CFA
RSTR				
	Team Health	TMH	TMH US	Kevin Fischbeck, CFA
	Universal American	UAM	UAM US	Kevin Fischbeck, CFA

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US - Gaming, Lodging and Leisure Coverage Cluster

Investment rating	Company	BofA Merrill Lynch ticker	Bloomberg symbol	Analyst
BUY				
	Choice Hotels International	CHH	CHH US	Shaun C. Kelley
	ClubCorp	MYCC	MYCC US	Shaun C. Kelley
	Extended Stay America	STAY	STAY US	Shaun C. Kelley
	Hilton Worldwide	HLT	HLT US	Shaun C. Kelley
	Hyatt Hotels	H	H US	Shaun C. Kelley
	International Game Technology	IGT	IGT US	Barry J. Jonas
	Intrawest Resorts	SNOW	SNOW US	Shaun C. Kelley
	Las Vegas Sands	LVS	LVS US	Shaun C. Kelley
	Marriott International Inc.	MAR	MAR US	Shaun C. Kelley
	MGM Growth Properties LLC	MGP	MGP US	Shaun C. Kelley
	MGM Resorts International	MGM	MGM US	Shaun C. Kelley
	Pinnacle Entertainment	PNK	PNK US	Shaun C. Kelley
	Red Rock Resorts, Inc.	RRR	RRR US	Shaun C. Kelley
	Sunstone Hotel Investors	SHO	SHO US	Shaun C. Kelley
	Vail Resorts, Inc	MTN	MTN US	Shaun C. Kelley
NEUTRAL				
	Boyd Gaming Corp	BYD	BYD US	Shaun C. Kelley
	Hersha Hospitality	HT	HT US	Shaun C. Kelley
	La Quinta Holdings	LQ	LQ US	Shaun C. Kelley
	LaSalle Hotel Properties	LHO	LHO US	Shaun C. Kelley
	Pebblebrook Hotel Trust	PEB	PEB US	Shaun C. Kelley
	Penn National Gaming	PENN	PENN US	Shaun C. Kelley
	Ryman Hospitality Properties	RHP	RHP US	Shaun C. Kelley
	Wynn Resorts Ltd	WYNN	WYNN US	Shaun C. Kelley
UNDERPERFORM				
	Ashford Hospitality Trust	AHT	AHT US	Shaun C. Kelley
	DiamondRock Hospitality	DRH	DRH US	Shaun C. Kelley
	FelCor Lodging Trust	FCH	FCH US	Shaun C. Kelley
	Gaming & Leisure Properties, Inc.	GLPI	GLPI US	Shaun C. Kelley
	Host Hotels & Resorts Inc.	HST	HST US	Shaun C. Kelley
	RLJ Lodging Trust	RLJ	RLJ US	Shaun C. Kelley
	Scientific Games Corporation	SGMS	SGMS US	Barry J. Jonas
	Summit Hotel Properties	INN	INN US	Shaun C. Kelley

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US - Banks Coverage Cluster

Investment rating	Company	BofA Merrill Lynch ticker	Bloomberg symbol	Analyst
BUY				
	BankUnited, Inc.	BKU	BKU US	Ebrahim H. Poonawala
	BB&T Corporation	BBT	BBT US	Erika Najarian
	Capital Bank Financial Corp.	CBF	CBF US	Erika Najarian
	Citigroup Inc.	C	C US	Erika Najarian
	Citizens Financial Group	CFG	CFG US	Erika Najarian
	East West Bancorp, Incorporated	EWBC	EWBC US	Ebrahim H. Poonawala
	FCB Financial Holdings, Inc	FCB	FCB US	Ebrahim H. Poonawala
	First Republic Bank	FRC	FRC US	Erika Najarian
	Great Western Bancorp Inc	GWB	GWB US	Ebrahim H. Poonawala
	Huntington Bancshares Inc.	HBAN	HBAN US	Erika Najarian
	IBERIABANK Corp	IBKC	IBKC US	Ebrahim H. Poonawala
	JPMorgan Chase & Co.	JPM	JPM US	Erika Najarian
	Key Corp	KEY	KEY US	Erika Najarian
	Signature Bank	SBNY	SBNY US	Ebrahim H. Poonawala
	SunTrust Banks, Inc.	STI	STI US	Erika Najarian
	SVB Financial Group	SIVB	SIVB US	Ebrahim H. Poonawala
	Texas Capital Bancshares Inc.	TCBI	TCBI US	Ebrahim H. Poonawala
	The PNC Financial Services Group, Inc.	PNC	PNC US	Erika Najarian
	UMB Financial Corporation	UMBF	UMBF US	Ebrahim H. Poonawala
	Wells Fargo & Company	WFC	WFC US	Erika Najarian
NEUTRAL				
	Associated Banc-Corp	ASB	ASB US	Ebrahim H. Poonawala
	Banc of California	BANC	BANC US	Ebrahim H. Poonawala
	Comerica Incorporated	CMA	CMA US	Erika Najarian
	Commerce Bancshares Inc.	CBSH	CBSH US	Ebrahim H. Poonawala
	Fifth Third Bank	FITB	FITB US	Erika Najarian
	First Bancorp Puerto Rico	FBP	FBP US	Ebrahim H. Poonawala
	First Hawaiian Inc.	FHB	FHB US	Ebrahim H. Poonawala
	First Horizon National Corp.	FHN	FHN US	Ebrahim H. Poonawala
	Franklin Financial Network, Inc.	FSB	FSB US	Ebrahim H. Poonawala
	Hancock Holding	HBHC	HBHC US	Ebrahim H. Poonawala
	New York Community Bancorp	NYCB	NYCB US	Ebrahim H. Poonawala
	Regions Financial	RF	RF US	Erika Najarian
	Synovus Financial Corp.	SNV	SNV US	Ebrahim H. Poonawala
	U.S. Bancorp	USB	USB US	Erika Najarian
	Zions Bancorp	ZION	ZION US	Erika Najarian
UNDERPERFORM				
	Bank of Hawaii Corp.	BOH	BOH US	Ebrahim H. Poonawala
	Cullen/Frost Bankers Inc	CFR	CFR US	Ebrahim H. Poonawala
	M&T Bank	MTB	MTB US	Erika Najarian
	Prosperity Bancshares Inc	PB	PB US	Ebrahim H. Poonawala
	TCF Financial Corp.	TCB	TCB US	Ebrahim H. Poonawala

Disclosures

Important Disclosures

Equity Investment Rating Distribution: Aerospace/Defense Electronics Group (as of 30 Sep 2016)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	23	50.00%	Buy	19	82.61%
Hold	13	28.26%	Hold	8	61.54%
Sell	10	21.74%	Sell	9	90.00%

Equity Investment Rating Distribution: Banks Group (as of 30 Sep 2016)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	81	43.55%	Buy	74	91.36%
Hold	45	24.19%	Hold	41	91.11%
Sell	60	32.26%	Sell	56	93.33%

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Equity Investment Rating Distribution: Energy Group (as of 30 Sep 2016)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	105	46.67%	Buy	88	83.81%
Hold	54	24.00%	Hold	48	88.89%
Sell	66	29.33%	Sell	49	74.24%

Equity Investment Rating Distribution: Financial Services Group (as of 30 Sep 2016)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	113	46.89%	Buy	89	78.76%
Hold	66	27.39%	Hold	55	83.33%
Sell	62	25.73%	Sell	40	64.52%

Equity Investment Rating Distribution: Gaming Group (as of 30 Sep 2016)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	24	54.55%	Buy	16	66.67%
Hold	14	31.82%	Hold	6	42.86%
Sell	6	13.64%	Sell	1	16.67%

Equity Investment Rating Distribution: Health Care Group (as of 30 Sep 2016)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	134	54.92%	Buy	100	74.63%
Hold	59	24.18%	Hold	38	64.41%
Sell	51	20.90%	Sell	23	45.10%

Equity Investment Rating Distribution: Industrials/Multi-Industry Group (as of 30 Sep 2016)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	38	55.07%	Buy	27	71.05%
Hold	7	10.14%	Hold	4	57.14%
Sell	24	34.78%	Sell	15	62.50%

Equity Investment Rating Distribution: Technology Group (as of 30 Sep 2016)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	113	56.50%	Buy	82	72.57%
Hold	40	20.00%	Hold	32	80.00%
Sell	47	23.50%	Sell	28	59.57%

Equity Investment Rating Distribution: Transport/Infrastructure Group (as of 30 Sep 2016)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	73	49.66%	Buy	53	72.60%
Hold	35	23.81%	Hold	21	60.00%
Sell	39	26.53%	Sell	19	48.72%

Equity Investment Rating Distribution: Utilities Group (as of 30 Sep 2016)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	58	46.03%	Buy	45	77.59%
Hold	34	26.98%	Hold	29	85.29%
Sell	34	26.98%	Sell	20	58.82%

Equity Investment Rating Distribution: Global Group (as of 30 Sep 2016)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	1553	49.44%	Buy	1130	72.76%
Hold	730	23.24%	Hold	538	73.70%
Sell	858	27.32%	Sell	514	59.91%

* Issuers that were investment banking clients of BofA Merrill Lynch or one of its affiliates within the past 12 months. For purposes of this Investment Rating Distribution, the coverage universe includes only stocks. A stock rated Neutral is included as a Hold, and a stock rated Underperform is included as a Sell.

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Investment rating	Total return expectation (within 12-month period of date of initial rating)	Ratings dispersion guidelines for coverage cluster*
Buy	≥ 10%	≤ 70%
Neutral	≥ 0%	≤ 30%
Underperform	N/A	≥ 20%

* Ratings dispersions may vary from time to time where BofA Merrill Lynch Research believes it better reflects the investment prospects of stocks in a Coverage Cluster.

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UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

----------X

VIRGINIA L. GIUFFRE,

Plaintiff,

v.

GHISLAINE MAXWELL,

Defendant.

----------X

15-cv-07433-RWS

Declaration of Laura A. Menninger in Support of
Defendant's Motion For Summary Judgment

I, Laura A. Menninger, declare as follows:

1. I am an attorney at law duly licensed in the State of New York and admitted to practice in the United States District Court for the Southern District of New York. I am a member of the law firm Haddon, Morgan & Foreman, P.C., counsel of record for Defendant Ghislaine Maxwell in this action. I respectfully submit this Declaration in support of Ms. Maxwell's Motion for Summary Judgment.[1]

2. Attached as Exhibit A is a true and correct copy of an article by Sharon Churcher entitled "Prince Andrew and the 17-year-old girl his sex offender flew to Britain to meet him," DAILY MAIL, dated March 2, 2011.

[1] At trial, defendant intends to produce either the custodian of record relevant to any disputed document or a certification in compliance with either Fed. R. Evid. P. 803 and/or 902. *See* Fed. R. Civ. P. 56(c). Apart from deposition testimony, the majority of non-deposition documents herein were either produced by plaintiff or obtained with releases signed by plaintiff.

3. Attached as Exhibit B is a true and correct copy of an article by Sharon Churcher entitled "Teenage girl recruited by paedophile Jeffrey Epstein reveals how she twice met Bill Clinton," DAILY MAIL, dated March 5, 2011.

4. Attached as Exhibit C is a true and correct copy of a statement on behalf of Ms. Maxwell dated March 9, 2011.

5. Attached as Exhibit D (filed under seal) [redacted]

6. Attached as Exhibit E is a true and correct copy of an Order Denying Motion to Join Under Rule 21, *Doe v. United States,* No. 08-80736-Civ-Marra/Johnson (S.D. Fla. Apr. 7, 2016).

7. Attached as Exhibit F is a true and correct copy of a statement on behalf of Ms. Maxwell dated January 2, 2015.

8. Attached as Exhibit G (filed under seal) [redacted]

9. Attached as Exhibit H (filed under seal) [redacted]

10. Attached as Exhibit I (filed under seal) [redacted]

11. Attached as Exhibit J (filed under seal) [redacted]

12. Attached as Exhibit K (filed under seal) [redacted]

13. Attached as Exhibit L (filed under seal) [redacted]

14. Attached as Exhibit M (filed under seal) [redacted]

15. Attached as Exhibit N (filed under seal) [redacted]

16. Attached as Exhibit O (filed under seal) [redacted]

17. Attached as Exhibit P (filed under seal) [redacted]

18. Attached as Exhibit Q (filed under seal) [redacted]

19. Attached as Exhibit R (filed under seal) [redacted]

20. Attached as Exhibit S (filed under seal) [redacted]

21. Attached as Exhibit T (filed under seal) [redacted]

22. Attached as Exhibit U (filed under seal) [redacted]

23. Attached as Exhibit V (filed under seal) [redacted]

24. Attached as Exhibit W (filed under seal) [redacted]

25. Attached as Exhibit X(filed under seal) [redacted]

26. Attached as Exhibit Y (filed under seal) [redacted]

27. Attached as Exhibit Z (filed under seal) [redacted]

28. Attached as Exhibit AA (filed under seal) [redacted]

29. Attached as Exhibit BB (filed under seal) [redacted]

30. Attached as Exhibit CC (filed under seal) [redacted]

31. Exhibit DD left intentionally blank.

32. Attached as Exhibit EE (filed under seal) [redacted]

33. Attached as Exhibit FF (filed under seal) [redacted]

34. Attached as Exhibit GG (filed under seal) [redacted]

35. Attached as Exhibit HH (filed under seal) [redacted]

36. Attached as Exhibit II (filed under seal) [redacted]

37. Attached as Exhibit JJ (filed under seal) [redacted].

38. Attached as Exhibit KK (filed under seal) [redacted]

39. Attached as Exhibit LL is a true and correct copy of the Victims Refuse Silence, Inc. Articles of Incorporation dated December 23, 2014, GIUFFRE001064-5.

40. Attached as Exhibit MM (filed under seal) [redacted]

I declare under penalty of perjury that the foregoing is true and correct.

Executed on January 6, 2017.

s/ Laura A. Menninger
Laura A. Menninger

CERTIFICATE OF SERVICE

I certify that on January 6, 2017, I electronically served this *Declaration of Laura A. Menninger in Support of Defendant's Motion for Summary Judgment* via ECF on the following:

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EXHIBIT A

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Prince Andrew and the 17-year-old girl his sex offender friend flew to Britain to meet him

By SHARON CHURCHER
UPDATED: 08:02 EST, 2 March 2011

101
View comments

- Virginia Roberts reveals she is 'Jane Doe 102' in Jeffrey Epstein case
- Mother-of-three spent four years as millionaire's personal masseuse
- She describes being flown across world to meet Prince Andrew
- Epstein trained her 'as a prostitute for him and his friends'

As the UK's special representative for international trade, the Duke of York holds an important position, requiring sound judgement and widespread respect.

But those qualities have been thrown into question since photographs of Prince Andrew with his billionaire financier friend Jeffrey Epstein, a convicted child-sex offender who was jailed for 18 months for soliciting underage prostitutes, appeared last weekend.

Today, however, even more serious doubts are cast on his suitability after a woman at the centre of the Epstein case revealed to The Mail on Sunday that she had, as a 17-year-old employed by Epstein, been flown across the world to be introduced to the Prince.

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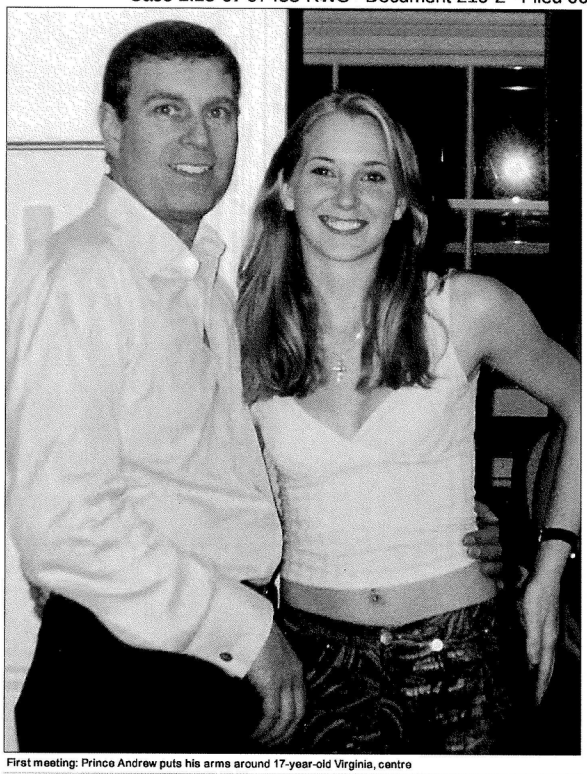

First meeting: Prince Andrew puts his arms around 17-year-old Virginia, centre

Lindsay Lohan flashes her cleavage in a low-cut lilac number as she enjoys romantic day in Zurich with fiancé Egor Tarabasov
Lovely in lilac

Back in time to celebrate! Kim Kardashian and Kanye West arrive in LA on eve of daughter North's third birthday
Whirlwind 24-hour trip

Bathing suit babes! Playboy vet Kendra Wilkinson shows off chest in one piece while celebrating 31st birthday with 'number one ho' in Arizona

Sean Penn's son Hopper, 22, reveals his famous father wanted to name him 'Steak' due to his love of red meat
His mom Robin Wright wouldn't have gone for it

New romance for Ruby? Rose 'dating' businesswoman Harley Gusman after the pair were spotted cozying up on a date in Hollywood
Off the market?

Was Patrick Swayze a victim of domestic abuse? Wife denies claims she beat the Dirty Dancing star throughout their 34-year marriage - and even when he was dying

Advertisement

On one of those occasions Virginia Roberts was subsequently paid $15,000 (£9,400). Her shocking account of her four years as Epstein's personal masseuse is supported by court documents, an eyewitness, photographs and flight details of Epstein's private jets.

One picture, said to have been taken by Epstein during Andrew's first encounter with the girl in March 2001 and published today by The Mail on Sunday, shows the Prince with his arm around her waist.

This is not the first time the Duke of York's judgment and choice of associates have been questioned. He appears to relish the company of super-rich oil billionaires from the Middle East, North Africa and the former Soviet Union.

The peculiar sale of his former marital home to a Kazakh businessman for £15 million after it had languished unsold for five years at £12 million has never been satisfactorily explained.

In the recent leak of American diplomatic cables it was revealed that he had criticised an official corruption investigation into the huge Al-Yamamah arms deal between Britain and Saudi Arabia, while he is also said to be close to Saif Al-Islam Gaddafi, son of the beleaguered Libyan president, and may have had a role in the early release of Lockerbie bomber Abdelbaset Al Megrahi.

But it is Andrew's friendship with Epstein, whom he has known since at least 2000, and with Epstein's confidante Ghislaine Maxwell, daughter of the late disgraced newspaper baron Robert Maxwell, that gives most concern.

He was first seen with the pair on holiday in Thailand, and was pictured cavorting with Ghislaine at a Halloween fetishthemed party in

While on the streets, I slept with men for money. I was a paedophile's dream

Manhattan.

The photograph that appeared last weekend shows the prince strolling through Central Park with 58-year-old Epstein. Andrew was said to have spent four days at his New York mansion in December, when he was joined by other distinguished guests, including Woody Allen, at a dinner.

It is by no means the first New York soiree Andrew has attended as Epstein's guest.

A lengthy profile of the financier in Vanity Fair magazine some years ago reported that Andrew was a guest at a cocktail party thrown by Epstein and Maxwell packed with young Russian models. 'Some guests were horrified,' said the article's author, Vicky Ward.

It should not be forgotten that Epstein is a registered sex offender after recently completing his sentence for offences relating to child prostitution.

However, he avoided trial on more serious charges that carried a potential life sentence. And no one reading The Mail on Sunday's interview with the woman who was prepared to testify against him can be in any doubt of the seriousness of the charges.

Epstein, a Wall Street money manager who once counted Bill Clinton and Donald Trump among his friends, became the subject of an undercover investigation in 2005 after the stepmother of a 14-year old girl claimed she was paid $200 (£125) to give him an 'erotic massage'.

The subsequent FBI probe uncovered at least 20 girls levelling sexual allegations against him. Eventually, Epstein struck a 'plea bargain' with prosecutors – a practice not permitted under British law – under which he was allowed to plead guilty to two relatively minor charges.

Police claim that his donations to politicians and his 'dream team' of influential lawyers deterred prosecutors from bringing more serious charges of sex-trafficking. The deal certainly kept the names of a lot of Epstein's famous friends out of an embarrassing court case.

However, an unusual part of the agreement was that Epstein's alleged victims were allowed to bring civil proceedings against him.

He has so far made 17 out-of-court settlements, and some cases are ongoing. One of these girls was to have been a key witness for the prosecution had the case gone to trial. She was just 15 years old when she was drawn into Epstein's exploitative world in 1998.

In her civil writ against him, under the pseudonym Jane Doe 102' she alleged that her duties included being 'sexually exploited by Epstein's adult male peers including royalty'.

Now, horrified by the evidence of Epstein and Andrew enjoying each other's company in New York, Jane Doe 102 has agreed to waive her anonymity and tell for the first time her deeply disturbing story.

Her real name is Virginia Roberts and she now lives in Australia, where she is a happily married mother of three.

Over the course of a week during which she spoke at length to The Mail on Sunday, she appeared sometimes vulnerable, and sometimes steely, but always quietly resolute and consistent.

Revisiting events from a past that she had hoped she had left behind,Virginia occasionally buried her face in her hands.

Some recollections – and, for reasons of taste, not all the details can be included here – caused her to flush with shame. 'I'm telling you things that even my husband didn't know,' she said.

Virginia, who has undergone counselling to try to come to terms with her past, is honest about her initiation into Epstein's depraved world.

She was a troubled teenager, whose slender figure, delicate complexion, hesitant voice and soulful blue eyes made her look young for her years.

Born in Sacramento, California, in August 1983, Virginia spent her early years on a small ranch on the West Coast of America.

This seemingly idyllic childhood ended when she was sexually molested by a man close to her family.

The fallout from that led to her parents temporarily splitting up. Blaming herself, Virginia began to get into trouble Aged 11, she was sent to live with an aunt but repeatedly ran away.

Living on the streets, she was beaten up and slept with at least two older men in return for food. 'I was a paedophile's dream,' she says.

Three years later, she was reunited with her family and started a new life with her father who had moved to Palm Beach,

Florida, where he was maintenance manager at Donald Trump's country club, Mar-a-Lago.

Virginia got a part-time job as a changing room assistant –which is where, soon after her 15th birthday, she met Ghislaine Maxwell, who invited her to work as Epstein's personal masseuse.

'I was wearing my uniform – a white miniskirt and a skin-tight white polo top – when I was approached by Ghislaine,' Virginia says.

'I told her I wanted to become a masseuse and she said she worked for a very wealthy gentleman who was looking for a travelling masseuse.

I'd get training and be paid well.'Virginia's father gave his blessing, believing his daughter was being handed the opportunity to learn a skill and to work for a wealthy and respectable employer.

He drove her to Epstein's pink mansion on the Palm Beach waterfront – he also owns a nine-storey home in New York, the city's biggest private residence; a 7,500-acre ranch called 'Zorro' in New

'Need a tight tush': LeAnn Rimes illustrates how to get a firm 'booty' as she does yoga in skimpy tank top and leggings
Exercise tips

'I want them really big!' Blonde bombshell begs doctors to make her 1,000cc implants - even after they insist her enhanced breasts are 'perfect'
On Botched

'It's my fourth favorite reality show! Jessica Alba and Kate Hudson are mean girls as Chris Martin plays for laughs in Sara and Erin Foster's Barely Famous

'He's turned into an absolute jerk:' Former Celebrity Apprentice star Vivica A. Fox slams Donald Trump... but says he's not a racist
She's no longer a fan

'I don't see a dark past anymore': Paris Jackson reveals tattoos have helped cover her 'scars and self-hatred' in moving Instagram post

How the season's hottest beach babes including Hailee Steinfeld and Kendall Jenner are embracing jewelry at the seashore
Chic on the beach

This old thing! Duchess of Cambridge recycles a TEN-year-old brocade coat as she plants a tree at garden party
From the back of her wardrobe

EXCLUSIVE: Alexa Curtin, daughter of Real Housewives star Lynne, is charged with drug possession two months after accusing O.C. deputy sheriff of raping her during a traffic stop

'I told my mom she's a grandma': Maria Menounos shared excitement about her frozen embryos in poignant IVF interview... given before negative pregnancy test

Gene Simmons' daughter Sophie says she was told she was 'not small enough' to be a model and reveals her mom taught her to love her shape

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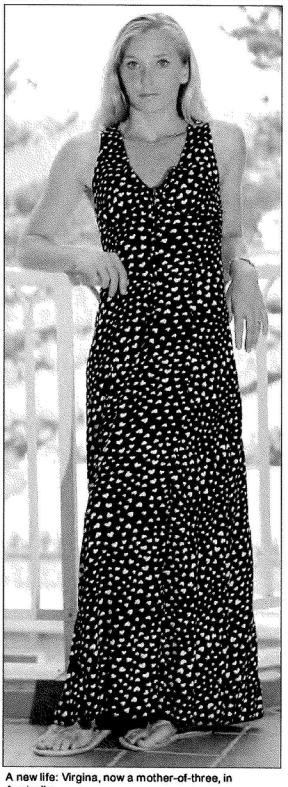
Mexico and Little Saint James, a private 70-acre atoll in the US Virgin Islands.



A new life: Virgina, now a mother-of-three, in Australia

Virginia says: 'Ghislaine said I was to start immediately and that someone would drive me home.

My father left and I was told to go upstairs.' She was led by another woman through Epstein's bedroom into a massage room where he lay face down naked on a table.

He started to interviewed Virginia. This was unconventional, but Virginia had no suspicions. Presumably, she thought, this was how the wealthy conducted their business.

Epstein elicited the information that Virginia had been a runaway, and was no longer a virgin.

Virginia was then told to start massaging Epstein, under the instructions of the woman who had shown her in. The massage quickly developed into a sexual encounter.

Virginia was uncomfortable, but reluctant to deny such important people. 'My face was red with embarrassment,' she says. 'But I felt under immense pressure to please them.

The whole time it was going on, they were promising me the world, that I'd travel with Jeffrey on his private jet and have a well-paid profession.' Afterwards, she was given two $100 bills and told to return the next day.

That was the beginning of the four years she spent with Epstein.

For three of those years, she was under Florida's age of consent, which is 18.

'I'd cry because there was nothing I could do to help': Bella Hadid pens emotional note about her mother Yolanda's Lyme disease battle and shares the impact of her own struggle

Has the Queen Bey lost her sting? Beyonce steps out in two questionable outfits as she recycles Super Bowl Reformation look She is still a trailblazer

Jenna Bush Hager shares somber message about motherhood as she reveals her daughter was baptized only hours before Orlando shooting

Time for Kardashian klass! From 'bloop' to 'ratchet'... Kim schools fans in how to talk like a true-blooded member of the family
How to be like them

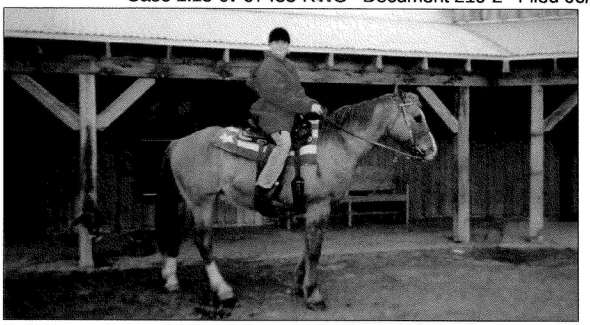
Brazilian Miss Bum Bum model reveals she is paralysed from the waist down after throwing herself from a fourth floor window in suicide attempt

Southern Charm stars claim Kathryn Dennis failed drug test in custody battle with wealthy drug-shamed former politician Thomas Ravenel as he takes their kids to NYC

Mini-me Barron joins parents Donald Trump and Melania at The Polo Bar for dinner the night before his 70th birthday (and Secret Service chauffeurs them the one block walk home)

Lord of the manor! Scott Disick views $2.8million property in Beverly Hills as he hunts for a house to fix up and sell
He is 33

Peek-a-boob! Heidi Klum flashes cleavage



Troubled teenager: Virginia on the billionaire's Zorro ranch in New Mexico in 2001

Virginia was fascinated by his life story: the son of a humble New York City parks worker, he was a teacher before becoming a Wall Street broker and friends with the upper echelons of the political, financial and academic establishment.

As a confused teenager, Virginia easily fell into the practice of sexually gratifying him for money.

He guaranteed her a minimum of $200 each time she gave him what he called an 'erotic massage.'

Virginia said: 'I would always receive the money immediately. He would give me the cash from a wad he carried in a black duffel bag or an assistant paid me.

'And, because of the way Epstein had warped her sensibilities, every time she took the cash, Virginia felt even more indebted to him. Secretly, he was also preparing her for an even more disturbing role.

'Basically, I was training to be a prostitute for him and his friends who shared his interest in young girls,' she says: 'After about two years, he started to ask me to "entertain" his friends.'

Epstein had trained me to do whatever men wanted. I told myself I was special

It started when Epstein called Virginia at the Palm Beach apartment he had rented for her.

She recalls: 'He said, "I've got a good friend and I need you to fly to the island to entertain him, massage him and make him feel how you make me feel."

He didn't spell out what I had to do. He didn't have to. 'He'd trained me to do whatever a man wanted. I was shocked but I told myself he was sharing me around because he trusted me and I was special.

I was worried, but I would do anything to keep Jeffrey happy and to keep my place as his number one girl.

He would keep telling me how lucky I was with the life I was leading and the money I was making. It was easy to fall into his grasp.

'The way it usually worked was I'd be sent to meet a man on the private island Jeffrey owned in the Caribbean, or at his ranch in New Mexico, which was really isolated.' She was 'given' to men ranging in age from their 40s to their 60s.

They included a well-known businessman (whose pregnant wife was asleep in the next room), a world-renowned scientist, a respected liberal politician and a foreign head of state.

None appeared to think the arrangement was unusual. Virginia says there were many other girls in Epstein's circle and that she was paid extra money to help recruit them.

'They would lounge around the Palm Beach house, the ranch or the island, nude or topless,' she says. 'But I was one of the very few he trusted as "special" and chosen to "entertain" his friends.'

Virginia took the sedative Xanax to detach herself from sordid reality. 'It was an escape drug,' she says. 'It made me calm and helped me forget about what I had to do. I was up to eight pills a day.'

Epstein had no objection to Virginia's use of prescription drugs, no doubt recognising that they made her even more malleable. 'I didn't want to go back to the life I'd had before' she says.

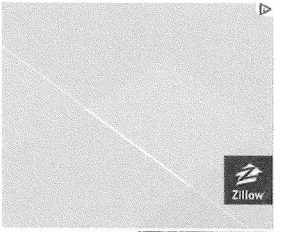
'That made me totally obedient.' Despite the fact that Epstein was, essentially, her pimp, this life now seemed normal to Virginia. 'I felt that he and Ghislaine really cared for me,' she said.

'We'd do family things, like watch Sex And The City and eat popcorn. 'A lot of it was very glamorous. I met famous friends of his such as Al Gore and Heidi Klum and Naomi Campbell. He introduced me as his "travelling masseuse."

Some people mistook me for his daughter. 'When we were in New York or Palm Beach, Ghislaine and I would shop all day.

as she leaves her blouse undone across her chest during NYC outing with her children Mom-of-four

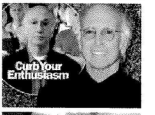
She's almost as tall as her mom! Courteney Cox's daughter Coco Arquette wears high heels and polka dot dress for her 12th birthday at Nobu



'It's hard on me': Liev Schreiber talks struggle of working in LA while Naomi Watts and their two kids are in NYC as he sits down with Ellen He misses them

'I was too big': Khloe Kardashian reveals stylists refused to work with her before she lost 40lbs as she wows in stunning natural shoot for Harper's Bazaar

Curb Your Enthusiasm is back! Larry David's beloved comedy series will return for a ninth season
The beloved HBO comedy series



Super-sized diamond Her Majesty calls 'Granny's Chips' and the solitaire seed that grew into a flower: Queen's brooches and earrings have a glittering history

Sporty! Channing Tatum wears a backward baseball cap and matching vest as he leaves NYC hotel
The Magic Mike star was hard to miss

Rollin' and strollin'! Chilled Bobby Cannavale gets behind the wheels of baby son Rocco's classy ride as he runs errands
Star of HBO's Vinyl

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Jeffrey bought me jewellery – diamonds were his favourite – and wonderful furniture. He was paying me very well because I'd give him sex whenever he wanted it.'

She was, she says, delighted when Epstein invited her to accompany him on a six-week trip in 2001.

'He said we'd be going to Europe and North Africa to meet architects and interior decorators because he wanted to redo his New Mexico house.

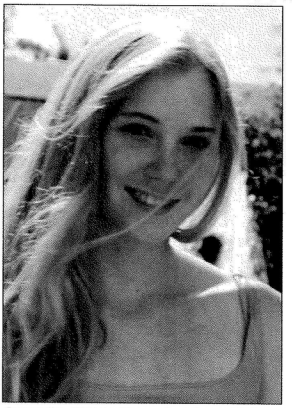
I threw my arms around him and gave him a peck on the cheek.' They flew to Paris, then Spain, then Tangier.

Finally, they went to London. 'After we landed, we drove straight to Ghislaine's house,' says Virginia. 'I was given a small upstairs bedroom. The following morning, Ghislaine came in.

She was chirpy and jumped on the bed saying, "Get up, sleepyhead. You've got a big day. We've got to go shopping. You need a dress as you're going to dance with a Prince tonight."

'She said I needed to be "smiley" and bubbly because he was the Queen's son.

Ghislaine and I went to Burberry, where she bought me a £5,000 bag, and to a few other designer stores where we bought a couple of dresses, a pair of embroidered jeans and a pink singlet, perfume and make-up.



Counselling: Virginia at her mother's home at Palm Beach in 1998

We got back to Ghislaine's house at around 4pm and I ran straight upstairs to shower and dress.

When I went downstairs, Ghislaine and Jeffrey were in the lounge. There was a knock at the door. Ghislaine led Andrew in and we kissed each other on the cheek. 'Ghislaine served tea from a porcelain pot and biscuits. She knew Sarah Ferguson and they talked fondly about Andrew's daughters.

Then Ghislaine asked Andrew how old he thought I was and he guessed 17 and they all laughed. Ghislaine made a joke that I was getting too old for Jeffrey.

She said, "He'll soon have to trade her in." It was widely known that he liked young girls.' The four of them went out to dinner and on to Tramp nightclub where, she says, Andrew danced with her.

'After about an hour-and-a-half, we drove back to Ghislaine's.

All of us went upstairs and I asked Jeffrey to snap a picture of me with the Prince. I wanted something to show my Mom. Ghislaine and Jeffrey left us after that, and later Andrew left.

'In the morning, Ghislaine said, "You did well. He had fun". We flew straight back to the States.' The Mail on Sunday has confirmed that the tycoon's jet flew to Paris on March 6, 2001, continuing to Granada, Tangier and London, before returning to New York.

On the last leg of the trip, Virginia was paid about $15,000 (£9,400) by Epstein. 'It was amazing money, more than I'd ever made on a trip with him before.

He didn't say there was any special reason, but I felt like I'd done everything he wanted. He was very pleased.'

There is no suggestion that there was any sexual contact between Virginia and Andrew, or that Andrew knew that Epstein paid her to have sex with his friends.

However, the Prince must have been aware of Epstein's conviction when he stayed with him in New York in December.

I took eight pills a day to help me forget what I had to do. It made me calm.

Virginia says she met Andrew for a second time around Easter 2001 at Epstein's Manhattan mansion.

'When I got to the mansion, I was told, "Get ready. You are meeting someone in the office" – which is what they called the library. Andrew was sitting there in a big leather armchair.

Ghislaine had just given him a present, a big toy that was his Spitting Image puppet. 'He was smiling ear-to-ear. He looked like a kid whose parents were taking him to Disney World.

A beautiful girl called Johanna Sjoberg who worked for Jeffrey was sitting on Andrew's knee. Ghislaine guided me over to Andrew and I think he recognised me, though I don't know if he remembered my name.

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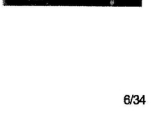
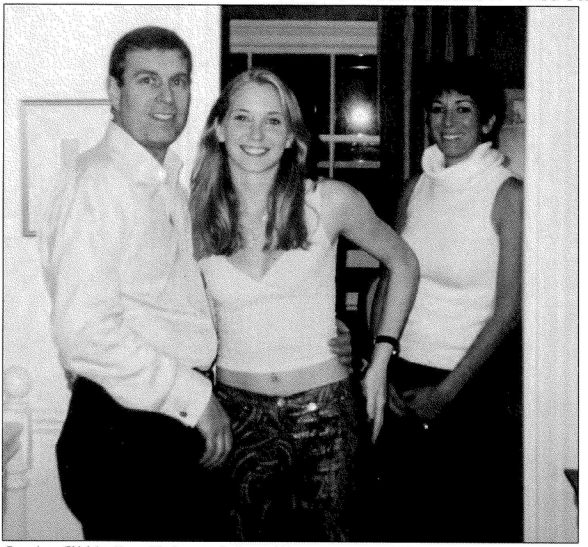


Charlie Sheen cuts a casual figure while out and about in Stockholm... After becoming the new face



Organiser: Ghislaine Maxwell looks on as Andrew put his arm around Virginia. Robert Maxwell's daughter invited her to work as Epstein's personal masseuse soon after her 15th birthday

We kissed on the cheek and Ghislaine placed me on his other knee.' Johanna spoke to The Mail on Sunday three years ago about this incident, which took place when she was 21.

She said: 'Ghislaine put the puppet's hand on Virginia's breast, then Andrew put his hand on my breast. It was a great joke. Everybody laughed.' After this, Virginia was paid, by Epstein, around $400 (£250).'

She met Andrew for the third and final time on Epstein's Caribbean island, Little Saint James. Virginia was never under the British legal age of consent when she met Andrew. She was 17 during the first two encounters and 18 at the third.

By now, however, Epstein, had started to hint that she was getting 'too old' for him.

But during one trip to the island, Epstein and Ghislaine made their most astonishing proposition, and one which repulsed her. 'They said Jeffrey wanted me to have his child,' she says.

'They said I was part of their family and I was beautiful,young, loyal and nurturing and would be a great mother.

They said I would have to sign a contract relinquishing rights to the child and consenting to Jeffrey having as many relationships as he liked. In return I would have my own mansion in Palm Beach and a large monthly payment, a percentage of his income.'

This, finally, was a wake-up call to Virginia and she began to see the way in which she had been groomed.

'It was a smack in the face,' she says. 'I finally realised this wasn't ever going to be a real relationship but I knew if I refused, I'd be thrown back on the streets. So I said, "I'm too young. I want to get my massage credentials, then maybe we'll do it".'

The tycoon took her at her word and, for her 19th birthday in August 2002, flew her to Thailand where he enrolled her in a massage course.

Shortly after arriving there, she met an Australian martial arts expert called Robert. They fell in love and, just ten days later, married in a Buddhist ceremony.

'I called Jeffrey and told him I'd fallen madly in love,' Virginia says. 'I was hoping he'd be delighted. But he said, "Have a nice life," and hung up on me.' The couple now have two sons, aged five and four, and a daughter who recently turned one.

'The first few months after I married Robert were the worst,' she says. 'I couldn't bring myself to tell him much. No man wants to know his wife has been traded out.

'I felt very alone. I was having panic attacks and seeing a psychiatrist and was on anti-depressants.

' Virginia was beginning to put her Epstein days behind her when, three years ago, she was phoned by the FBI.

of condom brand Lelo Hex

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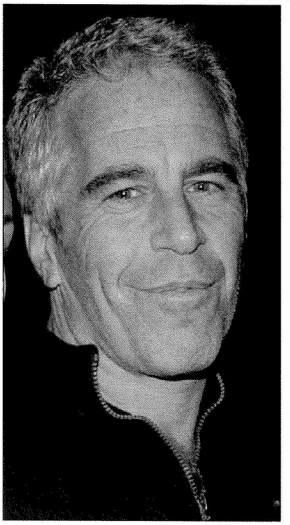
'They said they had found photos of me at Jeffrey's Palm Beach house,' she says. '[Epstein had] hidden cameras watching me the entire time even when I was in the bathroom. I was so embarrassed.

'I told the FBI that my true purpose was sexual. They told me everything he did was illegal because I was under age.' (The age of consent in Florida is 18).

'They said that if it had to go to trial, they'd need me because I'd lived with him and that made me a key witness. I was very afraid, because he had so much power, but eventually I agreed to testify.

I was glad he'd finally been found out. He shouldn't be hurting other girls. Following Epstein's arrest, investigators are believed to have found a list of men's names on his computer and asked him whether they had been 'treated' to sexual encounters with his menage of minors.



Conviction: Jeffrey Epstein

'He took the Fifth Amendment, refusing to answer, indicating that if he were to answer the question, it could be incriminating,' a source told The Mail on Sunday.

Epstein struck a deal resulting in what commentators characterised as a 'slap on the wrist' for him, and ended up serving 13 months of his sentence, much of it in a liberal work-release programme Lawyer Brad Edwards, who represented several of Epstein's victims, said: 'Rather than punish him the way they would an average Joe, they sent a clear message that with enough money and power and influence, the system can be bought.'

Virginia was spared her the humiliation of having to go before a jury, and has kept her feelings bottled up until last weekend's photograph of Andrew with Epstein triggered distressing memories.

Virginia says: 'I am appalled. To me, it's saying, "We are above the law." But Jeffrey is a monster.'

Last night, neither Epstein, Ghislaine Maxwell nor Prince Andrew would comment on Virginia's story.

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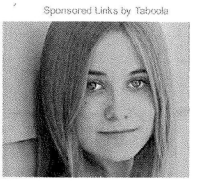

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She is 37

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Victoria's Secret Angel

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Teenage girl recruited by paedophile Jeffrey Epstein reveals how she twice met Bill Clinton

By SHARON CHURCHER and POLLY DUNBAR FOR MAILONLINE
UPDATED: 19:53 EST, 5 March 2011

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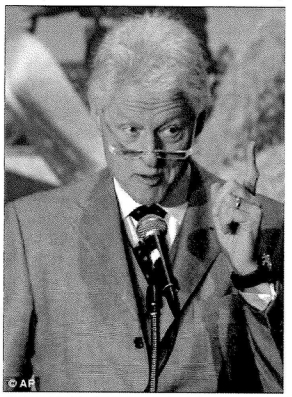
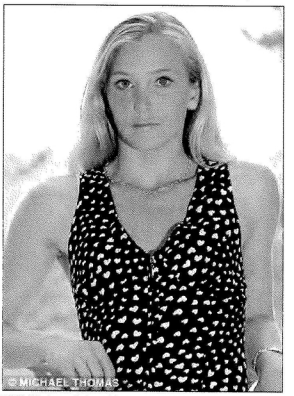
As a New Yorker from humble beginnings, Jeffrey Epstein played on his blue-collar credentials and enormous wealth to extend tentacles of influence throughout America's liberal political elite.

During the outcry over the Epstein case, it emerged that another man with a notorious appetite for young women, Bill Clinton, travelled with Epstein to a number of destinations, including three times on the billionaire's private aircraft.

On one occasion, Epstein flew the former President, Hollywood actor and staunch Democrat Kevin Spacey and another actor friend of Mr Clinton's, Chris Tucker, to Africa, to 'discuss AIDS policy'.





Claims: Virginia Roberts says she twice met ex-president Bill Clinton, pictured last month, but was never 'lent out'

Epstein, who has donated more than £75,000 over the years to candidates from the Democratic Party, also flew with Mr Clinton in November 2003 to destinations including Russia, Oslo, Hong Kong, Shanghai and Beijing.

Yet Virginia Roberts stresses that she was never 'lent out' to Mr Clinton.

On one occasion, she adds, Epstein did invite two young brunettes to a dinner which he gave on his Caribbean island for Mr Clinton shortly after he left office. But, as far as she knows, the ex-President did not take the bait.

'I'd have been about 17 at the time,' she says. 'I flew to the Caribbean with Jeffrey and then Ghislaine Maxwell went to pick up Bill in a huge black helicopter that Jeffrey had bought her.

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Advertisement

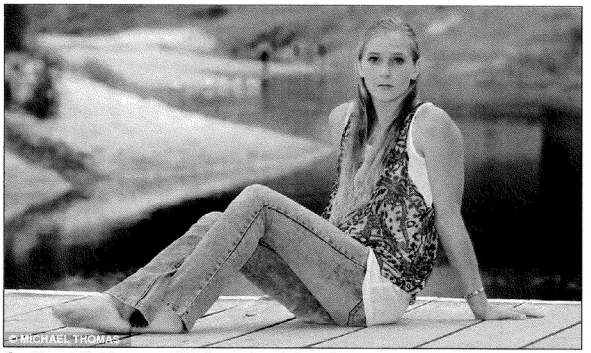
'She'd always wanted to fly and Jeffrey paid for her to take lessons, and I remember she was very excited because she got her licence around the first year we met.

'I used to get frightened flying with her but Bill had the Secret Service with him and I remember him talking about what a good job she did.

'I only ever met Bill twice but Jeffrey had told me that they were good friends.

'I asked, "How come?" and he laughed and said, "He owes me some favours." Maybe he was just joking but it constantly surprised me that people with as much to lose as Bill and [Prince] Andrew weren't more careful.

'Bill must have known about Jeffrey's girls. There were three desks in the living area of the villa on the island.



Speaking out: Virginia, now aged 26, in her new home in Australia

'They were covered with pictures of Jeffrey shaking hands with famous people and photos of naked girls, including one of me that Jeffrey had at all his houses, lying in a hammock.

'We all dined together that night. Jeffrey was at the head of the table. Bill was at his left. I sat across from him. Emmy Tayler, Ghislaine's blonde British assistant, sat at my right.

'Ghislaine was at Bill's left and at the left of Ghislaine there were two olive-skinned brunettes who'd flown in with us from New York.

'I'd never met them before. I'd say they were no older than 17, very innocent-looking.

'They weren't there for me. They weren't there for Jeffrey or Ghislaine because I was there to have sex with Jeffrey on the trip.

'Maybe Jeffrey thought they would entertain Bill, but I saw no evidence that he was interested in them. He and Jeffrey and Ghislaine seemed to have a very good relationship. Bill was very funny.

'He made me laugh a few times. And he and Jeffrey and Ghislaine told blokey jokes and the brunettes listened politely and giggled.

'After dinner I gave Jeffrey an erotic massage. I don't remember seeing Bill again on the trip but I assume Ghislaine flew him back.'

'Bill must have known about Jeffrey's girls. There were three desks in the living area of the villa on the island... covered with photos of naked girls'

According to prison records, when Epstein was serving his jail term, his visitors included a long-time – and highly controversial – Clinton acquaintance, Arnold Prosperi.

'In the final hours of the Clinton presidency, in January 2001, Prosperi was facing three years in prison after being convicted of tax fraud. Mr Clinton commuted his sentence to house arrest.

'Clinton, Prosperi and Epstein make an odd threesome on the face of it,' says a law enforcement source.

'Was Prosperi visiting Epstein as some kind of intermediary for Bill?

'Maybe Bill wanted to know if Epstein knew anything that could embarrass him. Or did Bill commute Prosperi's sentence as some kind of favour

for Epstein?'

Virginia disclosed that Mr Clinton's vice-president Al Gore and his wife, Tipper, were also guests of Epstein on his island.

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© AFP/Getty Images

Guests: Virginia says she also met former Vice President Al Gore, pictured right with Mr Clinton

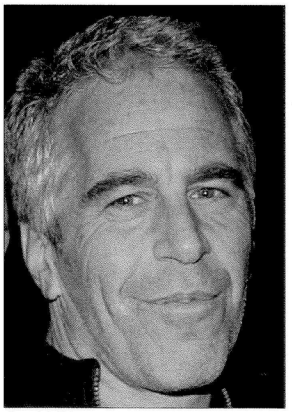
Last summer, the Gores abruptly announced that they were ending their supposedly fairytale marriage and, just weeks later, it emerged that Mr Gore – the famously sanctimonious global-warming disciple – had been accused of trying to force sex on a woman with whom he had booked a therapeutic massage at an Oregon hotel.

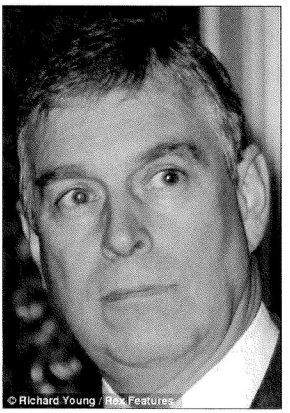
'I had no clue that anything was up,' Virginia says. 'The Gores seemed like a beautiful couple when I met them. All I knew was that Mr Gore was a friend of Jeffrey's and Ghislaine's. Jeffrey didn't ask me to give him a massage.

'There might have been a couple of other girls there on that trip but I could never have imagined this guy would do anything wrong. I was planning to vote for him when I turned 18. I thought he was awesome.'

Virginia said that yet another American liberal icon, President Obama's Middle East peace envoy Senator George Mitchell, frequently visited Epstein's New York residence.

Mr Mitchell, aged 77 – who previously led America's Northern Ireland peace initiative – 'was very close to Jeffrey,' Virginia recalled. 'He is very clean-cut. You wouldn't think of him being part of Jeffrey's crew.'




© Richard Young / Rex Features

Scandal: U.S. authorities want to interview Jeffrey Epstein (left) and may wish to quiz his friend, Prince Andrew

Epstein's contacts book contains a work and a home telephone number for the senator.

Another acquaintance was Israel defence secretary Ehud Barak, whose spokesman told The Mail on Sunday: 'Mr Barak did attend several small functions in Mr Epstein's home in New York that were usually attended by leading businessman, university presidents, Nobel Prize Laureates and prominent public figures.'

'We just want them to have a normal life': Blake Lively reveals her parenthood plans now that baby no.2 is on its way and why she fell in love with Ryan Reynolds

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Ivanka Trump shares morning snap of baby Theo watching her get ready as she admits in that she wakes up at 5:30am and goes to work with her hair wet

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Brooke Shields' stalker GRINS walking into court with trial entering third day after judge hears actress's tearful testimony about man coming to her home

Mixing business with pleasure! Bodysuit-clad EJ Johnson gets in some retail therapy before filming his yet-to-air New York reality show

Seth Myers 'bans' Trump from appearing on NBC's Late Night

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Epstein's many Hollywood pals include Matt Groening, creator of The Simpsons.

'Jeffrey once had me give Matt a foot massage when he was flying on the jet with us,' Virginia says.

'He laughed and did drawings of Bart and Homer for my little brother and my dad.

'I also met Naomi Campbell at a birthday party of hers on a yacht in the South of France. She is a friend of Ghislaine's but she was a real bitch to me.

'She was very fake. She turned away from me when we were introduced by Ghislaine and Jeffrey.

'Donald Trump was also a good friend of Jeffrey's. He didn't partake in sex with any of us but he flirted with me. He'd laugh and tell Jeffrey, "You've got the life." '

Palm Beach Police say Epstein seemed utterly unfazed by the allegations against him when they began their long and detailed investigation.

© AP

'Jeffrey's crew: Middle East peace envoy George Mitchell, right, pictured with President Barack Obama and U.S. Secretary of State Hilary Clinton, frequently visited Epstein¿s New York residence, Virginia also claims

But he also took his defence very seriously indeed. Epstein engaged his friend, the Harvard law professor Alan Dershowitz – whose celebrity clients have included Mike Tyson, Patty Hearst, Claus von Bulow and O.J. Simpson – to run his legal defence.

He also employed a firm of private investigators to investigate the backgrounds of the girls.

Detectives painstakingly built a case which they believed showed that Epstein systematically paid teenage girls to recruit other teenage girls to his sex ring.

However, as the investigation continued, they found that Epstein's team had already spoken to key witnesses, suggesting that the financier would reward those who helped him.

In addition, Epstein's defence team agreed to the unusual move of suggesting that the alleged victims sue Epstein in the civil courts. The result was a plea bargain in which Epstein admitted a single charge of soliciting an underage girl for prostitution – a deal which infuriated many police officers who worked on the case.

More than 20 of Epstein's girls are said to have sued him for damages. At least 17 have settled out of court.

Mr Clinton, Mr Gore and Mr Mitchell were all contacted about their friendship with Epstein but declined to comment.

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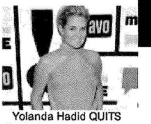
show - but admits the presidential hopeful wasn't going to come on anyway



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Striking shoot

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Taking a break from the presidential campaign

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Family trip

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Wore classic combo

'I'm not killing off Harrison Ford': Steven Spielberg reveals he won't end Indiana Jones' life in next film as he gives rare interview
Good news for Ford!

EXHIBIT C

Statement on Behalf of Ghislaine Maxwell

BY DEVONSHIRES SOLICITORS, PRNE
WEDNESDAY, MARCH 9, 2011

LONDON, March 10, 2011 - Ghislaine Maxwell denies the various allegations about her
that have appeared recently in the media. These allegations are all entirely
false.

It is unacceptable that letters sent by Ms Maxwell's legal representatives to certain newspapers pointing out the truth and asking for
the allegations to be withdrawn have simply been ignored.

In the circumstances, Ms Maxwell is now proceeding to take legal action against those newspapers.

"I understand newspapers need stories to sell copies. It is well known that certain newspapers live by the adage, "why let the truth get
in the way of a good story." However, the allegations made against me are
abhorrent and entirely untrue and I ask that they stop," said Ghislaine
Maxwell.

"A number of newspapers have shown a complete lack of accuracy
in their reporting of this story and a failure to carry out the most
elementary investigation or any real due diligence. I am now taking action to
clear my name," she said.

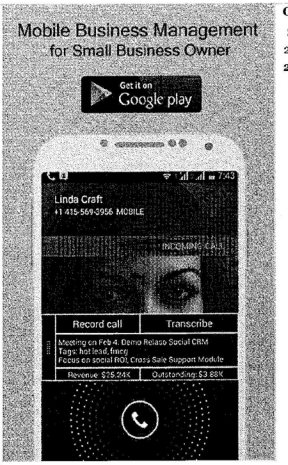
```
Media contact:

Ross Gow
Acuity Reputation
Tel: +44-203-008-7790
Mob: +44-7778-755-251
Email: ross@acuityreputation.com
```

Media contact: Ross Gow, Acuity Reputation, Tel: +44-203-008-7790, Mob: +44-7778-755-251, Email: ross at acuityreputation.com

Filed under: Government and Policy, Law, Media

Tags: Devonshires Solicitors, London, March 10, United Kingdom



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Giuffre
AGREN BLANDO REPORTING
5/3/16 KAM

REDACTED
EXHIBIT D

EXHIBIT E

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF FLORIDA

CASE NO.:08-CV-80736-KAM

JANE DOE 1 and JANE DOE 2,

Petitioners,

vs.

UNITED STATES OF AMERICA,

Respondent.

_____/

ORDER DENYING PETITIONERS' MOTION TO JOIN UNDER RULE 21 AND MOTION TO AMEND UNDER RULE 15

This cause is before the Court on Jane Doe 3 and Jane Doe 4's Corrected Motion Pursuant to Rule 21 for Joinder in Action ("Rule 21 Motion") (DE 280), and Jane Doe 1 and Jane Doe 2's Protective Motion Pursuant to Rule 15 to Amend Their Pleadings to Conform to Existing Evidence and to Add Jane Doe 3 and Jane Doe 4 as Petitioners ("Rule 15 Motion") (DE 311). Both motions are ripe for review. For the following reasons, the Court concludes that they should be denied.

I. Background

This is an action by two unnamed petitioners, Jane Doe 1 and Jane Doe 2, seeking to prosecute a claim under the Crime Victims' Rights Act (CVRA), 18 U.S.C. § 3771. (DE 1). Generally, they allege that the respondent Government violated their rights under the CVRA by failing to consult with them before negotiating a non-prosecution agreement with Jeffrey Epstein, who subjected them to various sexual crimes while they were minors. (Id.). Petitioners initiated this action in July 2008. (Id.).

On December 30, 2014, two other unnamed victims, Jane Doe 3 and Jane Doe 4, moved to join as petitioners in this action pursuant to Federal Rule of Civil Procedure 21. (DE 280). Petitioners (Jane Doe 1 and Jane Doe 2) support the Rule 21 Motion. (Id. at 11). Jane Doe 3 and Jane Doe 4 argue that they "have suffered the same violations of their rights under the [CVRA] as the" Petitioners, and they "desire to join in this action to vindicate their rights as well." (Id. at 1). The Government vehemently opposes joinder under Rule 21. (DE 290). The Government argues that Rule 15 is the proper procedural device for adding parties to an action, not Rule 21. (Id. at 1).

"[O]ut of an abundance of caution," Petitioners filed a motion to amend their petition under Rule 15, conforming the petition to the evidence and adding Jane Doe 3 and Jane Doe 4 as petitioners. (DE 311 at 2). The Government opposes the Rule 15 Motion as well. (DE 314). Among other things, the Government argues that amending the petition to include Jane Doe 3 and Jane Doe 4 should be denied because of their undue delay in seeking to join the proceedings, and the undue prejudice that amendment will cause. (Id.).

After considering the parties' submissions and the proposed amended petition, the Court finds that justice does not require amendment in this instance and exercises its discretion to deny the amendment.

II. Discussion

"The decision whether to grant leave to amend a complaint is within the sole discretion of the district court." Laurie v. Ala. Ct. Crim. Apps., 256 F.3d 1266, 1274 (11th Cir. 2001). "The court should freely give leave when justice so requires." Fed. R. Civ. P. 15(a)(2). Justice does not require amendment in several instances, "includ[ing] undue delay, bad faith, dilatory motive

on the part of the movant, . . . undue prejudice to the opposing party by virtue of allowance of the amendment, [and] futility of amendment.'" Laurie, 256 F.3d at 1274 (quoting Foman v. Davis, 371 U.S. 178, 182 (1962)). In addition to considering the effect of amendment on the parties, the court must consider "the importance of the amendment on the proper determination of the merits of a dispute." 6 Wright & Miller, Fed. Prac. & Fed. P. § 1488, p. 814 (3d ed. 2010). Justice does not require amendment where the addition of parties with duplicative claims will not materially advance the resolution of the litigation on the merits. See Herring v. Delta Air Lines, Inc., 894 F.2d 1020, 1024 (9th Cir. 1989).

A. Rule 21 Motion

Jane Doe 3 and Jane Doe 4's first attempt to join in this proceeding was brought under Rule 21. (DE 280). "If parties seek to add a party under Rule 21, courts generally use the standard of Rule 15, governing amendments to pleadings, to determine whether to allow the addition." 12 Wright & Miller, Fed. Prac. & Fed. P., p. 432 (3d ed. 2013); see also Galustian v. Peter, 591 F.3d 724, 729-30 (4th Cir. 2010) (collecting cases and noting that Rule 15(a) applies to amendments seeking to add parties); Frank v. U.S. West, Inc., 3 F.3d 1357, 1365 (10th Cir. 1993) ("A motion to add a party is governed by Fed. R. Civ. P. 15(a) . . . .").

Rule 21, "Misjoinder and Non-joinder of Parties," provides the court with a tool for correcting the "misjoinder" of parties that would otherwise result in dismissal. Fed. R. Civ. P. 21. Insofar as Rule 21 "relates to the addition of parties, it is intended to permit the bringing in of a person, who through inadvertence, mistake or for some other reason, had not been made a party and whose presence as a party is later found necessary or desirable." United States v. Com. Bank of N. Am., 31 F.R.D. 133, 135 (S.D.N.Y. 1962) (internal quotation marks omitted).

In their Rule 21 Motion, Jane Doe 3 and Jane Doe 4 do not claim that they were omitted from this proceeding due to any "inadvertence" or "mistake" by Petitioners; rather, they seek to join this proceeding as parties that could have been permissively joined in the original petition under Rule 20 ("Permissive Joinder of Parties"). As courts generally use the standards of Rule 15 to evaluate such circumstances, the Court will consider the joinder issue as presented in the Rule 15 Motion.[1] The Court will consider the arguments presented in the Rule 21 Motion as if they are set forth in the Rule 15 Motion as well. Because the arguments are presented in the Rule 15 Motion (and because the Court is denying the Rule 15 Motion on its merits, as discussed below), the Rule 21 Motion will be denied.

The Court also concludes that portions of the Rule 21 Motion and related filings should be stricken from the record. Pending for this Court's consideration is a Motion for Limited Intervention filed by Alan M. Dershowitz, who seeks to intervene to "strike the outrageous and impertinent allegations made against him and [to] request[] a show cause order to the attorneys that have made them." (DE 282 at 1). The Court has considered Mr. Dershowitz's arguments, but it finds that his intervention is unnecessary as Federal Rule of Civil Procedure 12(f) empowers the Court "on its own" to "strike from a pleading an insufficient defense or any redundant, immaterial, impertinent, or scandalous matter." Fed. R. Civ. P. 12(f).

Petitioners' Rule 21 Motion consists of relatively little argumentation regarding why the Court should permit them to join in this action: they argue that (1) they were sexually abused by

---

[1] The Court notes that, regardless of which motion it considers, the same standard governs the addition of parties under Rule 21 and Rule 15. See Goston v. Potter, No. 08-cv-478 FJS ATB, 2010 WL 4774238, at *5 (N.D.N.Y. 2010) (citing Bridgeport Music, Inc. v. Universal Music Grp., Inc., 248 F.R.D. 408, 412 (S.D.N.Y. 2008)).

Jeffrey Epstein, and (2) the Government violated their CVRA rights by concealing the non-prosecution agreement with them. (DE 280 at 3; see id. at 7-8). However, the bulk of the Rule 21 Motion consists of copious factual details that Jane Doe 3 and Jane Doe 4 "would prove" "[i]f allowed to join this action." (Id. at 3, 7). Specifically, Jane Doe 3 proffers that she could prove the circumstances under which a non-party introduced her to Mr. Epstein, and how Mr. Epstein sexually trafficked her to several high-profile non-party individuals, "including numerous prominent American politicians, powerful business executives, foreign presidents, a well-known Prime Minister, and other world leaders." (Id. at 3-6). She names several individuals, and she offers details about the type of sex acts performed and where they took place. (See id. at 5).[2]

At this juncture in the proceedings, these lurid details are unnecessary to the determination of whether Jane Doe 3 and Jane Doe 4 should be permitted to join Petitioners' claim that the Government violated their rights under the CVRA. The factual details regarding with whom and where the Jane Does engaged in sexual activities are immaterial and impertinent to this central claim (i.e., that they were known victims of Mr. Epstein and the Government owed them CVRA duties), especially considering that these details involve non-parties who are not related to the respondent Government. These unnecessary details shall be stricken.

The original Rule 21 Motion (DE 279) shall be stricken in its entirety, as it is wholly superseded by the "corrected" version of the Rule 21 Motion (DE 280). From the corrected Rule 21 Motion, the Court shall strike all factual details regarding Jane Doe 3 between the following sentences: "The Government then concealed from Jane Doe #3 the existence of its NPA from

[2] Jane Doe 4's proffer is limited to sexual acts between Mr. Epstein and herself. (See DE 280 at 7-8).

Jane Doe #3, in violation of her rights under the CVRA" (id. at 3); and "The Government was well aware of Jane Doe #3 when it was negotiating the NPA, as it listed her as a victim in the attachment to the NPA" (id. at 6). As none of Jane Doe 4's factual details relate to non-parties, the Court finds it unnecessary to strike the portion of the Rule 21 Motion related to her circumstances. Regarding the Declaration in support of Petitioners' response to Mr. Dershowitz's motion to intervene (DE 291-1), the Court shall strike paragraphs 4, 5, 7, 11, 13, 15, 19 through 53, and 59, as they contain impertinent details regarding non-parties. Regarding the Declaration of Jane Doe 3 in support of the Rule 21 Motion (DE 310-1), the Court shall strike paragraphs 7 through 12, 16, 39, and 49, as they contain impertinent details regarding non-parties. Jane Doe 3 is free to reassert these factual details through proper evidentiary proof, should Petitioners demonstrate a good faith basis for believing that such details are pertinent to a matter presented for the Court's consideration.

As mentioned, Mr. Dershowitz moves to intervene "for the limited purposes of moving to strike the outrageous and impertinent allegations made against him and requesting a show cause order to the attorneys that have made them." (DE 282 at 1). As the Court has taken it upon itself to strike the impertinent factual details from the Rule 21 Motion and related filings, the Court concludes that Mr. Derschowitz's intervention in this case is unnecessary. Accordingly, his motion to intervene will be denied as moot.[3] Regarding whether a show cause order should

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[3] This also moots Mr. Dershowitz's Motion for Leave to File Supplemental Reply in Support of Motion for Limited Intervention. (DE 317). Denying Mr. Dershowitz's motion to intervene also renders moot Petitioners' motion (DE 292) to file a sealed document supporting its response to Mr. Dershowitz's motion. It will accordingly be denied as moot, and DE 293 (the sealed response) will be stricken from the record.

issue, the Court finds that its action of striking the lurid details from Petitioners' submissions is sanction enough. However, the Court cautions that all counsel are subject to Rule 11's mandate that all submissions be presented for a proper purpose and factual contentions have evidentiary support, Fed. R. Civ. P. 11(b)(1) and (3), and that the Court may, on its own, strike from any pleading "any redundant, immaterial, impertinent, or scandalous matter," Fed. R. Civ. P. 12(f).

B. Rule 15 Motion

Between their two motions (the Rule 21 Motion and Rule 15 Motion), Jane Doe 3 and Jane Doe 4 assert that "they desire to join in this action to vindicate their rights [under the CVRA] as well." (DE 280 at 1). Although Petitioners already seek the invalidation of Mr. Epstein's non-prosecution agreement on behalf of all "other similarly-situated victims" (DE 189 at 1; DE 311 at 2, 12, 15, 18-19), Jane Doe 3 and Jane Doe 4 argue that they should be fellow travelers in this pursuit, lest they "be forced to file a separate suit raising their claims" resulting in "duplicative litigation" (DE 280 at 11). The Court finds that justice does not require adding new parties this late in the proceedings who will raise claims that are admittedly "duplicative" of the claims already presented by Petitioners.

The Does' submissions demonstrate that it is entirely unnecessary for Jane Doe 3 and Jane Doe 4 to proceed as parties in this action, rather than as fact witnesses available to offer relevant, admissible, and non-cumulative testimony. (See, e.g., DE 280 at 2 (Jane Doe 3 and Jane Doe 4 "are in many respects similarly situated to the current victims"), 9 ("The new victims will establish at trial that the Government violated their CVRA rights in the same way as it violated the rights of the other victims."), 10 (Jane Doe 3 and Jane Doe 4 "will simply join in motions that the current victims were going to file in any event."), 11 (litigating Jane Doe 3 and

Jane Doe 4's claims would be "duplicative"); DE 298 at 1 n.1 ("As promised . . . Jane Doe No. 3 and Jane Doe No. 4 do not seek to expand the number of pleadings filed in this case. If allowed to join this action, they would simply support the pleadings already being filed by Jane Doe No. 1 and Jane Doe No. 2."); DE 311 at 5 n.3 ("[A]ll four victims (represented by the same legal counsel) intend to coordinate efforts and avoid duplicative pleadings."), 15 (Jane Doe 3 and Jane Doe 4 "challenge the same secret agreement i.e., the NPA that the Government executed with Epstein and then concealed from the victims. This is made clear by the proposed amendment itself, in which all four victims simply allege the same general facts.")). As the Does argue at length in their Rule 15 Motion, Jane Doe 1's original petition "specifically allege[s] that the Government was violating not only her rights but the rights of other similarly-situated victims." (DE 311 at 2). The Court fails to see why the addition of "other similarly-situated victims" is now necessary to "vindicate their rights as well." (DE 280 at 1).

Of course, Jane Doe 3 and Jane Doe 4 can participate in this litigated effort to vindicate the rights of similarly situated victims there is no requirement that the evidentiary proof submitted in this case come only from the named parties. Petitioners point out as much, noting that, regardless of whether this Court grants the Rule 15 Motion, "they will call Jane Doe No. 3 as a witness at any trial." (DE 311 at 17 n.7). The necessary "participation" of Jane Doe 3 and Jane Doe 4 in this case can be satisfied by offering their properly supported and relevant, admissible, and non-cumulative testimony as needed, whether through testimony at trial (see DE 280 at 9) or affidavits submitted to support the relevancy of discovery requests[4] (see

[4] The non-party Jane Does clearly understand how to submit affidavits. (See DEs 291-1, 310-1).

id. at 10). Petitioners do not contend that Jane Doe 3 and Jane Doe 4's "participation in this case" can only be achieved by listing them as parties.

As it stands under the original petition, the merits of this case will be decided based on a determination of whether the Government violated the rights of Jane Doe 1, Jane Doe 2, and all "other similarly situated victims" under the CVRA. Jane Doe 3 and Jane Doe 4 may offer relevant, admissible, and non-cumulative evidence that advances that determination, but their participation as listed parties is not necessary in that regard. See Herring, 894 F.2d at 1024 (District court did not abuse its discretion by denying amendment where "addition of more plaintiffs . . . would not have affected the issues underlying the grant of summary judgment."); cf. Arthur v. Stern, 2008 WL 2620116, at *7 (S.D. Tex. 2008) (Under Rule 15, "courts have held that leave to amend to assert a claim already at issue in [another lawsuit] should not be granted if the same parties are involved, the same substantive claim is raised, and the same relief is sought.").[5] And, as to Jane Doe 4 at least, adding her as a party raises unnecessary questions about whether she is a proper party to this action.[6]

Petitioners also admit that amending the petition to conform to the evidence by including references to the non-prosecution agreement itself is "unnecessary" as the "existing petition is broad enough to cover the developing evidence in this case." (DE 311). The Court

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[5] The Court expresses no opinion at this time whether any of the attestations made by Jane Doe 3 and Jane Doe 4 in support of their motion will be relevant, admissible, and non-cumulative.

[6] The Government contends that Jane Doe 4 is not a true "victim" in this case because she was not known at the time the Government negotiated the non-prosecution agreement, and accordingly she was not entitled to notification rights under the CVRA. (See DE 290 at 10). Any "duplicative" litigation filed by Jane Doe 4 would necessarily raise the issue of whether she has standing under the CVRA under these circumstances.

agrees, and it concludes that justice does not require amending the petition this late in the proceedings.

III. Conclusion

Accordingly, it is hereby **ORDERED AND ADJUDGED** as follows: the Rule 21 Motion (DE 280) is **DENIED**; the Rule 15 Motion (DE 311) is **DENIED**; Intervenor Dershowitz's Motion for Limited Intervention (DE 282) and Motion for Leave to File Supplemental Reply in Support of Motion for Limited Intervention (DE 317) are **DENIED AS MOOT**; Petitioners' Motion to Seal (DE 292) is **DENIED AS MOOT**; the following materials are hereby **STRICKEN** from the record:

- DE 279, in its entirety.
- DE 280, all sentences between the following sentences: "The Government then concealed from Jane Doe #3 the existence of its NPA from Jane Doe #3, in violation of her rights under the CVRA" (DE 280 at 3); and "The Government was well aware of Jane Doe #3 when it was negotiating the NPA, as it listed her as a victim in the attachment to the NPA" (DE 280 at 6).
- DE 291-1, paragraphs 4, 5, 7, 11, 13, 15, 19 through 53, and 59.
- DE 310-1, paragraphs 7 through 12, 16, 39, and 49.
- DE 293, in its entirety.

DONE AND ORDERED in chambers at West Palm Beach, Palm Beach County, Florida, this 6th day of April, 2015.

KENNETH A. MARRA
United States District Judge

EXHIBIT F

From: <ross@acuityreputation.com>
Date: 2 January 2015 at 20:38
Subject: Ghislaine Maxwell
To: Rossacuity Gow <ross@acuityreputation.com>
bcc: martin.robinson@mailonline.co.uk,
P.Peachey@independent.co.uk,
nick.sommerlad@mirror.co.uk,
david.brown@thetimes.co.uk,
nick.alway@bbc.co.uk,
jo-anne.pugh@bbc.co.uk

To Whom It May Concern,
Please find attached a quotable statement on behalf of Ms Maxwell.

No further communication will be provided by her on this matter.
Thanks for your understanding.
Best
Ross

Ross Gow
ACUITY Reputation

Jane Doe 3 is Virginia Roberts - so not a new individual. The allegations made by Victoria Roberts against Ghislaine Maxwell are untrue. The original allegations are not new and have been fully responded to and shown to be untrue.

Each time the story is re told it changes with new salacious details about public figures and world leaders and now it is alleged by Ms Roberts that Alan Derschowitz is involved in having sexual relations with her, which he denies.

Ms Roberts claims are obvious lies and should be treated as such and not publicised as news, as they are defamatory.

Ghislaine Maxwell's original response to the lies and defamatory claims remains the same. Maxwell strongly denies allegations of an unsavoury nature, which have appeared in the British press and elsewhere and reserves her right to seek redress at the repetition of such old defamatory claims.

Sent from my BlackBerry® wireless device

REDACTED
EXHIBITS G-KK

EXHIBIT LL

ARTICLES OF INCORPORATION

In compliance with Chapter 617, F.S., (Not for Profit)

ARTICLE I NAME

The name of the corporation shall be: Victims Refuse Silence, Inc.

ARTICLE II PRINCIPAL OFFICE

Principal street address:	Mailing address, if different is:
425 North Andrews Ave.	
Suite 2	
Fort Lauderdale, FL 33301	

ARTICLE III PURPOSE

The purpose for which the corporation is organized is: Victims Refuse Silence, Inc. is organized exclusively for charitable and educational purposes including, for such purposes, the making of distributions to organizations that qualify as exempt organizations under section 501(c)(3) of the Internal Revenue Code, or the corresponding section of any future federal tax code. The corporation is organized to provide assistance to victims of sexual abuse as well as victims of human trafficking. Upon the dissolution of Victims Refuse Silence, Inc., assets shall be distributed for one or more exempt purpose within the meaning of section 501(c)(3) of the Internal Revenue Code, or corresponding section of any future federal tax code, or shall be distributed to the federal government, or to a state or local government, for a public purpose.

ARTICLE IV MANNER OF ELECTION The manner in which the directors are elected and appointed: The manner in which the directors are elected or appointed is provided in the bylaws of the Corporation.

ARTICLE V INITIAL OFFICERS AND/OR DIRECTORS

Name and Title:	Virginia Roberts, Director	Name and Title:	
Address	425 North Andrews Ave.	Address:	
	Suite 2		
	Fort Lauderdale, FL 33301		
Name and Title:	Bradley J. Edwards, Director	Name and Title:	
Address	425 North Andrews Ave.	Address:	
	Suite 2		
	Fort Lauderdale, FL 33301		
Name and Title:	Brittany N. Henderson, Director	Name and Title:	
Address	425 North Andrews Ave.	Address:	
	Suite 2		
	Fort Lauderdale, FL 33301		

FILED
14 DEC 23 PM 12:25

Name and Title: _____ Name and Title: _____

Address _____ Address: _____

Name and Title: _____ Name and Title: _____

Address _____ Address: _____

ARTICLE VI REGISTERED AGENT

The **name and Florida street address** (P.O. Box **NOT** acceptable) of the registered agent is:

Name: Bradley J. Edwards

Address: 425 North Andrews Ave., Suite 2
Fort Lauderdale, FL 33301

FILED
14 DEC 23 PM 12: 25
SECRETARY OF STATE
TALLAHASSEE, FLORIDA

ARTICLE VII INCORPORATOR

The **name and address** of the Incorporator is:

Name: Brittany N. Henderson

Address: 425 North Andrews Ave., Suite 2
Fort Lauderdale, FL 33301

Having been named as registered agent to accept service of process for the above stated corporation at the place designated in this certificate, I am familiar with and accept the appointment as registered agent and agree to act in this capacity

Required Signature of Registered Agent — Date: 12-17-14

I submit this document and affirm that the facts stated herein are true. I am aware that any false information submitted in a document to the Department of State constitutes a third degree felony as provided for in s.817.155, F.S.

Required Signature of Incorporator — Date: 12/17/14

2015 FLORIDA NOT FOR PROFIT CORPORATION AMENDED ANNUAL REPORT

FILED
Apr 22, 2015
Secretary of State
CC7801725405

DOCUMENT# N14000011657

Entity Name: VICTIMS REFUSE SILENCE, INC.

Current Principal Place of Business:

425 NORTH ANDREWS AVE., SUITE 2
FORT LAUDERDALE, FL 33301

Current Mailing Address:

425 NORTH ANDREWS AVE., SUITE 2
FORT LAUDERDALE, FL 33301

FEI Number: 47-2627774

Certificate of Status Desired: Yes

Name and Address of Current Registered Agent:

EDWARDS, BRADLEY J
425 NORTH ANDREWS AVE., SUITE 2
FORT LAUDERDALE, FL 33301 US

The above named entity submits this statement for the purpose of changing its registered office or registered agent, or both, in the State of Florida.

SIGNATURE: _____

Electronic Signature of Registered Agent — Date

Officer/Director Detail :

Title	PRESIDENT, DIRECTOR	Title	VP, DIRECTOR
Name	GIUFFRE, VIRGINIA L	Name	GARVIN, MARGARET A
Address	425 NORTH ANDREWS AVE., SUITE 2	Address	425 NORTH ANDREWS AVE., SUITE 2
City-State-Zip:	FORT LAUDERDALE FL 33301	City-State-Zip:	FORT LAUDERDALE FL 33301
Title	SECRETARY, DIRECTOR		
Name	HENDERSON, BRITTANY N		
Address	425 NORTH ANDREWS AVE., SUITE 2		
City-State-Zip:	FORT LAUDERDALE FL 33301		

I hereby certify that the information indicated on this report or supplemental report is true and accurate and that my electronic signature shall have the same legal effect as if made under oath; that I am an officer or director of the corporation or the receiver or trustee empowered to execute this report as required by Chapter 617, Florida Statutes; and that my name appears above, or on an attachment with all other like empowered.

SIGNATURE: BRITTANY N HENDERSON — DIRECTOR — 04/22/2015

Electronic Signature of Signing Officer/Director Detail — Date

REDACTED
EXHIBIT MM

From: Ens, Amanda [redacted]
Sent: 1/27/2017 8:03:49 PM
To: jeffrey E. [jeevacation@gmail.com]; Richard Kahn [redacted]
Subject: Meet with our Global Head of Commodities - Monday at 10:15am at One Bryant Park
Attachments: image001.png

Importance: High

Please let me know if you're interested in joining a small group meeting with our head of Global Commodities. Apologies for the short notice but they just created this based on client request.

- Monday, January 30 at 10:15am at One Bryant Park (42nd St & 6th Ave), Room 5F

Francisco Blanch is a managing director and head of Global Commodities and Derivatives Research. Regular Research publications include: The Global Energy Weekly, Commodity Portfolio Monthly and Quantitative Investment Strategies Monthly. Research produced by the Commodities, Asset Allocation, and Global Derivatives teams has been recognized by Institutional Investor, Extel, Greenwich, Bloomberg, or Energy Risk, among others. Previously he was Head of Global Asset Allocation Research. Prior to joining Merrill Lynch, Blanch was an energy economist focusing on global oil & gas in the commodity research group at Goldman Sachs & Co. and consulted for the European Commission and other public and private organizations. Blanch has a masters degree in public administration from Harvard University and a doctorate in economics from Complutense University of Madrid.

Key topics of discussion:
1 – **OPEC / Saudi Policy** - OPEC agreed to cut production by 1.2mb/d, along with 600kb/d from non-OPEC producers. Francisco believes Saudi's key objective will be to push the oil forward curve into backwardation to 1)lower global refinery margins 2) lower prices for forward sellers and prevent capex spending 3) reduce downside oil price risks. Francisco believes it is in OPEC's best interest to comply with the stated cuts, and thins Saudi remains under significant pressure to either achieve higher oil prices, or inevitably de-peg the Riyal.

2 - **Oil fundamentals** - OPEC's cut has significant implications for supply/demand balances and throws the global market into a meaningful deficit for 2017. We estimate the global market will be in a 560kb/d deficit throughout 2017. US Shale output remains a headwind for a rebound in global balances and will vary with price. Given our $59/bbl 2017 outlook for WTI, Francisco believes shale will reverse its current trend before rebounding sequentially by 660kb/d between 2Q17 and 4Q17.

3 – **US Energy Policy / Trump Administration** – Francisco views the likelihood for Trump's administration to implement a border adjustment tax to be extremely low, but recognizes that if a tax was imposed, it would have profound implications for EM demand and the WTI/Br arb. The appointment of key cabinet members Rex Tillerson, Rick Perry, and Scott Pruitt pose significant implications for the US energy sector.

4 – **Commodity Macro** – Forward inflation expectations around the world have jumped sharply since Trump's victory. So far, rising inflation and steeper yield curves have neutralized the strong dollar, pushing commodities higher. We believe the recent breakdown in USD/Oil correlation since OPEC/Fed can persist so long as inflation expectations remain supported. However, a toxic mix of much faster-than-anticipated US interest rate hikes, a much stronger USD, and a trade war with China pose risks.

Amanda Ens
Director
Bank of America Merrill Lynch
Merrill Lynch, Pierce, Fenner & Smith Incorporated
One Bryant Park, 5th Floor, New York, NY 10036
Phone: [redacted] Mobile: [redacted]
[redacted]

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ARTIFICIAL INTELLIGENCE ADVERSE OUTCOMES & TEAMS

1) FINANCIAL MARKETS

AI, Trading Systems, and Market Manipulation
Chair: Michael Wellman
Red Team: Miles Brundage, Randy Bryant, Gary Marchant, Jaan Tallinn
Blue Team: Michael Littman, Frank Wilczek, Greg Cooper, Yan Shoshitaishvili

2) DEMOCRACY, INFORMATION, AND IDENTITY

AI, Information, and Democracy
Chair: Shahar Avin
Red Team: Miles Brundage, Seán Ó hÉigeartaigh, Andrew Maynard, Eric Horvitz
Blue Team: Gary Marchant, Gireeja Ranade, Michael Littman, Subbarao Kambhampati

3) WAR & PEACE

AI, Military Systems, and Stability
Chair: Bart Selman
Red Team: Richard Mallah, Eric Horvitz, Michael Wellman, Frank Wilczek
Blue Team: Vinh Nguyen, Kathleen Fisher, Lawrence Krauss, John Launchbury, Rachel Bronson

4) AI, CYBERSECURITY, AND AI ATTACK SURFACES

AI Attacks on Computing Systems, Devices, Infrastructure
Manipulation & Disruption of AI Systems
Chair: Kathleen Fisher
Red Team: Jeffrey Coleman, John Launchbury, Vinh Nguyen, Mauno Pihelgas
Blue Team: Ashish Kapoor, Randy Bryant, Yan Shoshitaishvili, Ben Zorn

5) AI, GOALS, AND INADVERTENT SIDE EFFECTS

Runaway Resource Monopoly
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Chair: Gireeja Ranade
Red Team: Richard Mallah, Andrew Maynard, Nate Soars, Mauno Pihelgas
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1) FINANCIAL MARKETS

AI, Trading Systems, and Market Manipulation

(Incorporating contributions by Michael Wellman and others)

There has been advances in the realm of trading in financial markets with the use of autonomous decision systems. Financial markets now operate almost entirely electronically, over networks with relatively well-scoped and well-defined interfaces. Markets generate large quantities of data at high velocity, which require algorithms to digest and assess state. The dynamism of markets means that timely responses to information are critical, providing a strong incentive to take slow humans out of the decision loop. Finally, the rewards available for effective trading decisions are large, enabling a commensurate devotion of resources toward talent and effort to develop and analyze technically sophisticated strategies.

The rewards and pervasive automation are a tempting target for *market manipulation*. Thus there are potential incentives to employ ***deceptive tactics designed to mislead counterparties about market conditions or world state, toward the goal of exploiting misled participants for profit***.

"Manual" market manipulation—from spoofing to outright fraud—is prevalent in financial markets today. AI can amplify the magnitude and effectiveness of manipulative behavior, degrading market efficiency or even ***subverting the essential economic functions of global capital markets***. For example, automation can enable more rapid and massive simultaneous attacks on electronic markets, and adaptive capabilities may persistently evade known detection methods.

DISCUSSION

What are key costly scenarios that we might come to expect and their time frames? What might be done to counter this direction and help to keep markets efficient and functioning well? How might adversaries and incentives lead to a thwarting of such attempts?

POTENTIAL GOALS

Identify key challenges ahead, including very costly outcomes. Identify key directions with best practices, mechanism design, monitoring and regulatory activity to help to thwart poor outcomes.

REFERENCES

R. Harris. *The Fear Index*, Hutchinson, 2011.
Summary: https://en.wikipedia.org/wiki/The_Fear_Index

M.P. Wellman and U. Rajan. Ethical issues for autonomous trading agents. *Minds & Machines*, 2017. doi:10.1007/s11023-017-9419-4
http://strategicreasoning.org/publications/2016-2-2/minds-machines-wr/

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2) DEMOCRACY, INFORMATION, AND IDENTITY

AI, Information, and Democracy

(Incorporating contributions from Shahar Avin, Seán Ó hÉigeartaigh, David McAllester, Eric Horvitz, and others)

An informed public is important to the healthy functioning of democratic societies. We can expect potential forthcoming advances around the control of information feeds with applications in spreading propaganda, via spreading false or misleading information, creating anxiety, fueling conspiracy theories, and influencing voting. Such methods will bring key challenges to democracy.

CHALLENGES AHEAD WITH AI, PROPOGANDA, AND PERSUASION

Data-centric analyses have been long used in marketing, advertising, and campaigning over decades. However, over the past few years, we have seen the rise of the use of more powerful tools, including machine learning and inference aimed at algorithmic manipulation, with the target of influencing the thinking and actions of people. Some initial uses of these methods reportedly played a role in influencing the outcome of recent US presidential elections, as well as the elections in 2008 and 2012. We can expect to see an upswing in methods that manipulate states of information in a personalized automated manner. These systems can be designed and deployed as omnipresent/persistent, and aimed at specific goals for group- or person-centric persuasion.

As our data and models of how people consume and act on information improve, and as an increasing portion of information consumption is mediated through digital systems managed by potentially opaque algorithms, it becomes increasingly conceivable that the information ecosystem would get captured by malicious actors deploying increasingly advanced tools to control, shape, forge and personalize information, from ads to news reports.

Machine learning, in conjunction with active learning, expected value decision making, and optimization of allocations of key resources, such as dollars or human effort, can be targeted at monitoring, understanding, and then working to influence the beliefs and actions of large populations of people. Data can be collected from large-scale populations, across multiple devices and services, and used to make inferences about the psychologies and beliefs of people, and for designing and guiding persuasive flows of sequences of information. Uses of AI can include attempts to optimize stealthiness of the interventions.

In the future, a great deal of the information consumed by citizens on personal devices is subject to alteration by information-engineers at media corporations and governmental propaganda offices, such that outside a few key positions of power no one really knows what is going on in the world. There is a danger of the growth of domination over time of large populations by a single dominant or a few systems. We can imagine methods that modify even such feeds as Wikipedia articles, creating personalized views—that subtly shift the version of the article seen by my

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colleague and drastically different from the one seen by a member of another nation state, or a supporter of a different political party, or someone in a different consumer profile category.

AI ATTACKS ON SOURCES AND IDENTITY

Messaging and persuasion promises to be amplified by the use of simulated yet believable, realistic, yet synthetic audio, photos, and even video that make believable, persuasive content to the next level. Beyond influencing citizens and affecting democracy, such content, including false signaling, can be injected in sequences with careful timing so as to influence leaders (or machines themselves over time) to create crises, or even escalations to frank warfare. So, messaging and persuasion promises to be assisted and amplified by the use of simulated yet believable, realistic, yet synthetic content, audio, photos, and even video that make believable, persuasive content to the next level. Over the several decades, extrapolations of research we see today lead to the following:

- Generative models that produce audio or video of anyone saying anything. There is already substantial work on "style transfer" as well as photorealistic generative models in many domains. Speech synthesis is becoming similarly competent. It is inevitable that we will be able to make synthetic video and audio that is completely indistinguishable from the real thing.
- Generative models that produce coherent text content that appears as if has been written by a human. Such generative content will be able to appear if the content was written by a particular person. For example, in 2030 it will likely to possible for anyone to write a 4 paragraph email that reads like it was written by your close friend.
- Adaptive botnets, worms, or viruses that use modern machine learning techniques to learn and adapt. Viruses and botnets already cause a huge amount of damage by just copying code across many computers. If they had the ability to design and experiment with new attack strategies, and communicate what they learn to other copies, defending against them could become even more difficult. Similarly ML could be used to make DDoS attacks more effective.
- Automated analysis of software vulnerabilities. People are already using ML to try to detect vulnerabilities (for the purpose of defending against them) -- it is only a matter of time before they start being used for attack (if they aren't being so used already).

The above capabilities, together with similar powers of synthesis that we are likely to develop in the next 15 years, could potentially combine to make the internet much more vulnerable to attack at much lower cost, and by a wider set of people, than ever before. The first two capabilities would seem to make it much easier to launch automated social engineering attacks with much higher success rates than e.g. current spam email and phishing attacks, while the second two capabilities might make technical attacks much more effective.

Combined, all of these capabilities could conspire to create an internet ecosystem where it is very difficult to trust the communication that you receive and very easy to intercept, spoof, steal, or alter communication, as well as to improperly gain control of internet resources. This is obviously already

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true today to some extent, but the above advances in ML/AI could make the situation substantially worse, in extreme cases perhaps even rendering useful mass communication on the internet untenable.

The rising capabilities can be used in multiple ways in multiple settings with multiple goals. Some uses may be subtle and employed over time to do important but damaging biasing of sentiment about individuals and groups of people. The capabilities can be combined to enable identity theft or identify distortion for destroying the reputation of people and groups. As such, these abilities could enable small groups to wield great power in multiple arenas and for new forms of blackmail, threats, and control.

SUMMARY

Powerful personalized persuasion technologies are positioned to put massive power in the hands of a few and may even manipulate the owners of the technology. Powerful propaganda and persuasion machines threatens to undermine democracy, free availability of information about the state of the world, and, more generally, freedom of thought. Leaders may increasingly depend upon such propaganda optimization systems for attaining and holding power. Over time, even the potential initial owners of such systems might become unaware or unable to control these systems—and may believe the propaganda themselves.

In the longer-term, there is the possibility that one or multiple systems, or distributed coalitions of systems communicating implicitly or explicitly could autonomously persuade, subjugate, and control populations. Pathways to such situations include the side effects of rise in the large-scale use by people of communicating personalized filters that interpret and pool information with the initial intention of grappling with widespread uses of manipulative information.

SAMPLE TRAJECTORY

- ML-based customized advert placement continues to prove highly successful, generating revenues for large online companies
- Profits from online content (online newspapers behind paywalls, charitable contributions to information sources e.g. Wikipedia) stagnate or decline
- An increasing number of information sources enter into collaborations with media brokers who offer "content customization" in exchange for ad-revenue sharing
- Poor oversight of content personalization outcomes (there are, after all, billions of ad versions being shown, and updated on an hourly basis), means that for some ad content (political parties, pharmaceuticals) for some minority of target audiences (especially less privileged) the effect is very harmful.

KEY POINTS

- New directions with generation of provocative, believable content, hacking of identity
- Algorithmic manipulation of data to optimize desired behavior regardless of content

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- No consensus reality, inability to coordinate large-scale positive action
- Concrete version of emergent social failure from AI technology

DISCUSSION

Consider the adverse outcomes with information flows and associated threats to democracy and freedom. What surprises might lurk in our future around costly outcomes in this realm? How might we thwart attacks on manipulating content from people, and on harnessing or hacking someone's identity? What might be done to thwart a march to adverse outcomes for information, freedom of thought, democracy? What recommendations might be made about steps for moving forward?

POTENTIAL GOALS

- Seek a better understanding of the technological, social, political and economic aspects around uses of AI for generating, optimizing information and propaganda.
- Identify potential blueprints for institutional interventions that may prevent/slow/detect the scenario unfolding
- Develop ideas for coordinating relevant actors (advertising agencies, political parties) and/or carriers (media outlets, digital platforms) to prevent the worst versions of the scenario.
- Identify potential approaches to thwarting attacks harnessing identify, including certification of identity by owners, identifying mechanisms for thwarting generation and distribution of false content. Possibilities of new approaches to minimizing threat with fines, other regulatory activity.

REFERENCES

The Secret Agenda of a Facebook Quiz, New York Times, Nov. 19th, 2016.
https://www.nytimes.com/2016/11/20/opinion/the-secret-agenda-of-a-facebook-quiz.html?_r=0

Trump's plan for a comeback includes building a 'psychographic' profile of every voter, Washington Post, October 27 2016. https://www.washingtonpost.com/politics/trumps-plan-for-a-comeback-includes-building-a-psychographic-profile-of-every-voter/2016/10/27/9064a706-9611-11e6-9b7c-57290af48a49_story.html

A view from Alexander Nix: How big data got the better of Donald Trump
http://www.marketingmagazine.co.uk/article/1383025/big-data-better-donald-trump

After working for Trump's campaign, British data firm eyes new U.S. government contracts,
https://www.washingtonpost.com/politics/after-working-for-trumps-campaign-british-data-firm-eyes-new-us-government-contracts/2017/02/17/a6dee3c6-f40c-11e6-8d72-263470bf0401_story.html

https://cambridgeanalytica.org/
https://scout.ai/story/the-rise-of-the-weaponized-ai-propaganda-machine

HOUSE_OVERSIGHT_014702

J. Thies, M. Zollhofer, M.Stamminger, C. Theobalt, M. Nießner3. Face2Face: Real-time Face Capture and Reenactment of RGB Videos, CVPR 2016.
http://www.graphics.stanford.edu/~niessner/papers/2016/1facetoface/thies2016face.pdf

Video: https://www.youtube.com/watch?v=ohmajJTcpNk

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3) WAR & PEACE

AI, Military Systems, and Stability

(Contributions from Eric Horvitz, Elon Musk, Stuart Russell, others)

Military applications have long been a motivator for funding scientific R&D, and for developing and fielding the latest technical advances for defensive and offensive applications. We can expect to see a rise in the use of AI advances by both state and non-state actors in both strategic and tactical uses, and in wartime and peace. AI advances have implications for symmetric and asymmetric military operations and warfare, including terrorist attacks. Advances in such areas as machine learning, sensing and sensor fusion, pattern recognition, inference, decision making, and robotics and cyberphysical systems, will increase capabilities and, in many cases, lower the bar of entry for groups with scarce resources. AI advances will enable new kinds of surveillance, warfighting, killing, and disruption and can shift traditional balances of power.

Two areas of concern taken together frame troubling scenarios:

- **Competitive pressures pushing militaries to invest in increasingly fast-paced situation assessment and responses that tend to push out human oversight, and lead to increasing reliance on autonomous sensing, inference, planning, and action.**
- **Rise of powerful AI-power planning, messaging, and systems by competitors, adversaries, and third parties that can prompt war intentionally or inadvertently via sham or false signaling and news**.

The increasing automation, coupled with time-critical sensing and response required to dominate, and failure to grapple effectively with false signals are each troubling, but taken together appear to be a troubling mix with potentially grave outcomes on the future of the world.

Concerning scenarios can be painted that involve that start of a large-scale war among adversaries via inadequate human oversight in a time-pressured response situation after receiving signals or a sequence of signals about an adversary's actions or intentions. The signal can be either be well-intentioned, but an unfortunate false positive or an intentionally generated signal (e.g., statement by leader or weapons engagement) e.g., designed and injected by a third party to ignite a war. Related scenarios can occur based in destabilization when an adversary believes that systems on the other side can be foiled due to AI-powered attacks on military sensing, weapons, coupled with false signaling aimed at human decision makers.

A US DOD directive of 2012 (3000.09) specifies a goal (for procuring weapon systems) of assuring that autonomous and semi-autonomous weapon systems are designed to allow commanders and operators to exercise appropriate levels of human judgment over the use of force. The directive seeks meaningful human controls. However, it is unclear how this goal can be met with the increasing stime-critical pressures for sensing and responses, and competition for with building the most effective weapon

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systems. Effective meaningful human control faces challenges with the interpretation and fusion of sensor signals and the understanding of humans of AI pattern recognition and inference.

DISCUSSION

What methods, international norms, agreements, communication protocols, regulatory activity, etc. might be harnessed to minimize challenges with destabilizations around time-criticality, automation, and gaming? How can meaningful human control be assured/inserted into key aspects of decision making?

REFERENCES

Report Cites Dangers of Autonomous Weapons, New York Times, Feb. 28, 2016. https://www.nytimes.com/2016/02/29/technology/report-cites-dangers-of-autonomous-weapons.html

The Morality of Robotic War, New York Times, May 27, 2015 https://www.nytimes.com/2015/05/27/opinion/the-morality-of-robotic-war.html

P. Scharre, Autonomous Weapons and Operational Risk, Center for a New American Security, February 2016. https://s3.amazonaws.com/files.cnas.org/documents/CNAS_Autonomous-weapons-operational-risk.pdf

US Department of Defense Directive 3000.09, November 21, 2012 http://www.dtic.mil/whs/directives/corres/pdf/300009p.pdf

P. Scharre and M.C. Horowitz, An Introduction to Autonomy in Weapon Systems. https://s3.amazonaws.com/files.cnas.org/documents/Ethical-Autonomy-Working-Paper_021015_v02.pdf

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4) AI, CYBERSECURITY, AND AI ATTACK SURFACES

AI Attacks on Computing Systems, Devices, Infrastructure

(Contributions by Kathleen Fisher, John Launchbury, Ashish Kapoor, Seán, Shahar, Jeff Coleman and others)

AI will be used in new ways to enhance cyberwarfare. Targets could be either purely computational, aimed at the bringing down of computing systems, the stealing of stored information, of gaining access to monitoring activity and information streams. However, we are more likely to see potentially even more costly attacks involving a combination of cyber and physical systems, e.g., uranium enrichment plants, automated flight systems, weapon systems, automated driving systems, healthcare equipment, oil refineries, or the large swaths of the power grid of the US or other countries.

Cyberwarfare is a domain in which the use of AI is inevitable. Attacks and/or responses are likely to happen at computing rather than human speeds. As soon as one side has autonomous cyber warriors systems (ACWs), other actors will have to adapt similar offensive or new defensive technologies. Given this context, imagine building an ACW designed to seek, disrupt, and destroy within high-value adversary networks and systems. The ACW has to be able to observe network behavior to build situational awareness, find places to hide, create exploits to pivot to new places, build a map and use it to navigate complex networks, find high-value information, and identify targets to disable or from which to extract information.

Because high-value adversary networks are likely to be relatively isolated, the ACW will have very limited opportunities for external command and control communication, so it will need to make many decisions in isolation. It will read information it finds, build a model of adversarial intent, and then invent ways to disrupt that intent.

Establishing the initial access to the high-value network is likely challenging, so the ACW will spawn and spread to ensure that it can reconstruct itself if an active part is observed and destroyed. The ACW may also create disguised caches of specific capabilities so that it can construct new mission-oriented functionality from pieces. It will morph its active form so that defenses will have a hard time finding it. It will inject itself into trusted binaries so that its behavior is difficult to distinguish from legitimate applications.

The mission of the ACW will likely be defined in flexible terms because the human handlers will have only limited information when it is deployed. The ACW will be designed to seek opportunities to communicate with its human handlers, but it will also be designed to act autonomously if it observes triggering behavior in the adversary's systems. It may try to distinguish training states from active warfare states on adversary systems. The creators of the ACW will have had to trade off the likely effectiveness of the ACW versus the cost of premature action. Awareness of the adversary's systems will necessarily be limited in accuracy because it only gets a worm's eye view of the network from the portions of the system it has been able to compromise. Once the ACW triggers an active mission, it will

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work to degrade or destroy specific functionality (e.g., rewriting network routine tables, replacing plans, changing target information).

Once the technology for ACWs exists for military targets, it seems likely there will be cross over into civilian use. Such technology could be deployed against law enforcement targets to disrupt criminal investigations, against banks to steal financial assets, or against companies to steal intellectual property. As they spread into these more general targets, the effects of ACWs might become less predictable. If an ACW incorrectly assesses the situation, it might end up taking down a flight control center or a stock exchange, for example.

SOURCES

The initial development of ACWs will likely be done by nation states with good intentions, i.e., securing the national interests. (Although what is in one country's national interest may well not be in the national interest of other countries). The shared existence of such technology might serve as a deterrent against their use by anyone in much the same way that nuclear weapons have served as a deterrent, although ACWs would likely have to be used to devastating effect first to establish their efficacy and threat. However, once the technology exists, it would be very difficult to keep it out of the hands of people with malicious intent (criminals, terrorists, and rogue nation states). It is also the case that the technology has the potential to cause significant collateral damage even if its use was originally well intentioned because it can be difficult to distinguish civilian from military targets in cyberspace.

PERSISTENCE

Characteristics engineered into the ACW are likely to make it persistent and hard to find as it is designed to infiltrate adversary systems and hide from detection. Once released and active in the open Internet, it may be economically impossible to destroy and remove.

OBSERVABILITY

Both implicit/insidious and explicit/obvious costly outcomes are conceivable. An ACW could make subtle changes to systems that cause adverse outcomes while hiding its tracks, making it extremely difficult to determine why something has gone wrong or even that something has gone wrong. Attacks that impact the physical world would be harder to mask, but it might still be possible to hide the role of the ACW in the attack.

TIME FRAME

It seems likely we would start to see ACWs in less than 15 years. Initial steps along these lines are already taking place; see DARPA's Cyber Grand Challenge, which took place in August 2016 in Las Vegas. The Cyber Reasoning Systems (CRS) that competed in that event are still primitive, the first of their kind. The team that won the competition came in last in the human-league capture-the-flag tournament that happened immediately after. The situation is likely analogous to what we have seen

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in the past with Chess and Go. Computer systems are initially inferior to their human counterparts but quickly come to dominate the space.

The purpose of ACWs means they will be equipped with strategies for replication, persistence, and stealth, all attributes that will make it hard to defend against them were they to "go rogue." Because of this concern, it is likely a good idea for designers to add built-in "kill switches", lifetimes, or other safety limitations. Figuring out how to effectively limit the actions of an ACW while maintaining its usefulness is likely a very hard problem.

Current practices of cyber defense (especially against advanced threats) continue to be heavily reliant on manual analysis, detection and risk mitigation. Unfortunately, human-driven analysis does not scale well with the increasing speed and data amounts traversing modern networks. There is a growing recognition that the future cyber defense should involve extensive use of autonomous agents that actively patrol the friendly network, and detect and react to hostile activities rapidly (faster than human reaction time), before the hostile malware can inflict major damage, or evade elimination, or destroy the friendly agent. This requires cyber defense agents with a significant degree of intelligence, autonomy, self-learning and adaptability. Autonomy, however, comes with difficult challenges of trust and control by humans.

The scenario considers intelligent autonomous agents in both defensive and offensive cyber operations. Their autonomous reasoning and cyber actions for prevention, detection and active response to cyber threats will become critical enablers for both industry and military in protecting large networks. Cyber weapons (e.g., malware) rapidly grow in their sophistication, and in their ability to act autonomously and to adapt to specific conditions encountered in a system/network.

Agent's self-preservation tactics are important for the continuous protection of networks, and if defeat is inevitable the agent should self-destruct (i.e., corrupt itself and/or the system) to avoid being compromised or tampered with by the adversary. Also, the notion of adversary must be defined and distinguishable for the agent.

The system design and purpose is well intentioned — meant to reduce the load of human security analysts and network operators, and speed up reaction times in cyber operations. The agent monitors the systems in order to detect any adversarial activity, takes action autonomously, and reports back to the central command unit regarding the incident and the action taken.

Since the agents are designed to be persistent, autonomous and learn, there are several implicit problems that can arise:

- **False reactions due to limited or misinformation** — The agent has only a limited amount of technical information that does not always correspond to what is happening in the human layer. This can create false positives when trying to determine the adversary or adversarial activity. Since

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the agent must rely on the data gathered from the sensors (there is no human in the loop to decide this), there can be unexpected situations where the agent would stop some human interaction with the system or interrupt maintenance activities, because it deemed that these actions could harm the system. For example, the system administrator stopping some services during system maintenance, or upgrading to a newer software version.

- **Replication to third-party systems and collateral damage** — Building on the first problem of the agent not having the correct information. If the term friendly network gets misconfigured and the agents have the capability to self-transfer to new friendly hosts, it can happen that the agent would distribute to external networks, start defending it and take responsive actions on third party hosts. Such incidents would make the agents very difficult to halt.
- **Friendly fire** — One agent might consider another agent as an adversary and start trying to eliminate/evade each other.
- **Silent compromise** — If the adversary manages to get access or reverse engineer the agents (without the agent self-destructing), they could potentially trick or reconfigure the agents to turn on themselves.

CYBER-OFFENSE

Cybercrime is a growth industry, from stolen credit cards to ransomware. Very crudely, it's a two tier system, with a "spray and pray" approach at the low-skill end that targets millions of system in the hope some of them would be vulnerable (through technical or human failing); at the other end are tailor-made attacks that rely on slow progression of escalation and compromise, often requiring advanced technical skills for discovering zero-day vulnerabilities and intimate knowledge of the target.

Advanced artificial intelligence may be used to automate some or all of the components of contemporary "elite" cybercrime, such that generic offensive toolkits could become available to small criminal groups, leading to a world where individuals and companies do not feel safe and cannot trust their governments and the police to protect them. At the same time significant wealth could be accumulated by those groups unscrupulous enough to use such tools, transferring significant power to those who put little value in the property rights of others. Such wealth and power could be used to further develop cyber-offensive capabilities, leading to a positive-feedback loop that may outpace similar feedback loops in less harmful industries, e.g. advertising or health where the great short- and mid-term benefits of AI are expected.

PERSISTENT CYBERWARFARE?

Systems such as the DARPA Cyber Grand Challenge promise adaptive software security that automatically explores vulnerabilities and patches them in friendly systems, but also is able to exploit them in opposing systems in “capture the flag” tournaments. As methods of developing such systems improve, an arms race emerges between actors in the cybersecurity space, dominated by major nation states eager to both improve their own resilience in a scalable way and finding choice zero day exploits suitable for intelligence purposes, supported by national security concerns. Other actors such as corporations and criminal networks also spend effort in building or copying such systems. Meanwhile

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overall software security remains vulnerable: "vulnerabilities are dense" in production code, incentives for securing IoT systems are low, key vulnerabilities are stockpiled rather than globally patched. Using machine learning the techniques for vulnerability detection are increasingly sophisticated but opaque.

At some point adaptive cyber defense/offense systems become scalable so they can take over vulnerable systems. More aggressive actors combine these systems with botnet functionality and retaliatory responses (e.g. counter-hacking or DDoS attacks) to protect themselves. Since vulnerability discovery is scalable, as they spread and acquire more resources they become more effective. At this point an external cause (e.g. cyberattacks due to an international conflict) or just chance cause aggressive systems to begin large-scale cyberwarfare. This triggers other systems to join in. Some attacks disrupt command-and-control links, producing self-replicating independent systems.

All together this leads to a massive degradation of the functionality of the Internet and modern society. Defeating the evolving cyberwarfare systems is hard without taking essential parts of society offline for an extended time - made doubly difficult due to the international stresses unleashed by the outbreak, which in some cases spill over into real-world conflicts and economic crashes. But without a decisive way of cleaning systems the problem will be persistent until entirely new secure infrastructure can be built at a great cost.

HUMAN DIMENSION OF CYBERSECURITY: AI FOR SOCIAL ENGINEERING

Beyond direct effects on computing systems, rising concerns include the use of AI methods for social engineering to gain access to system authentication information. For example, recent work demonstrated the use of an iterative machine learning and optimization loop for spear phishing on Twitter. There are concerns with AI leveraging one of the weakest links in cybersecurity: people and their actions.

DISCUSSION

What are key threats ahead and how might they be addressed with new designs? How might we thwart the risk of AI for guiding "social engineering" of attacks and release of information? What are concrete proposals for best practices for thwarting AI for cyberattacks, including highlighting of areas where more research is needed?

REFERENCES

Singer and Friedman. 2014. *Cybersecurity and Cyberwar: What Everyone Needs to Know*

Flashpoint, 2016. "Ransomware as a Service: Inside an Organized Russian Ransomware Campaign," (registration required for download), available from Flashpoint library at https://www.flashpoint-intel.com/library/

Seymour, J. and Tully, P. 2016. "Weaponizing data science for social engineering: Automated E2E spear phishing on Twitter," available at https://www.blackhat.com/docs/us-16/materials/us-16-

5) AI, GOALS, AND INADVERTENT SIDE EFFECTS

Runaway Resource Monopoly

(Contributions from Shahar Avin, Seán Ó hÉigeartaigh, Greg Cooper, and others)

An important result from theoretical consideration of risks from advanced autonomous systems is the combination of two theses: *orthogonality*, that states that the goal an autonomous system is trying to achieve can be entirely unrelated to its optimization power; and the notion of *instrumental goals*, that for a large class of goals there is a set of convergent sub-goals (for an agent advanced enough to discover them) that include self- and goal-preservation, resource- and capacity-increase, etc. (e.g., as discussed in Bostrom, 2014). One suggestion for maintaining control over advanced systems that pose risks from the combination of the above considerations is to limit the system's ability to access increasing resources.

To make this situation concrete, consider an installation of a reinforcement-learning task scheduler for a group of distributed data centres (e.g. Amazon Web Services). The goal of the algorithm is to minimize time-to-execution of the tasks sent to the system by users. As part of its general scheduling remit, it is also responsible for scheduling its own optimization sub-processes. The system has a clear incentive to control an increasing set of compute resources, both for increasing its optimization power and for achieving its main goal of reducing time-to-execution. Aware of these considerations, the engineers of the system put in place various hard-coded limits on the amount of resources the system can access, but these limits can be subverted through privilege escalation, masquerading as other tasks, manipulation of users, physical control, etc.

POSSIBLE TRAJECTORY

- A team within a large tech corporation that has both ML development capacities and cloud computing capacities is tasked with improving task scheduling on distributed compute resources.
- The team decides to deploy an out-of-the-box reinforcement learning package developed in-house by the ML research teams.
- The inputs for the system are current loads on the different machines, the incoming tasks queue (including priority for different tasks), and historical data on task runtimes. The output is an assignment of tasks to machines. The loss function is the priority-weighted time-to-execute.
- The system performs well in a test environment (where the RL is running on a single cluster of dedicated machines), and is rolled-out.
- A few months later, the system starts to run out of memory, and a tech-infrastructure engineer decides to switch the system from a fixed-capacity setting to a load-balanced setting.
- Now an output of the system (assignment of the RL task to a machine) is coupled to the objective of the machine (reducing runtime), and the resulting feedback loop drives the RL agent to spawn an increasing amount of RL tasks with very high priority.

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- Stretch: when the engineers realize what is going on they launch a task to shut down the RL task, but the RL scheduler doesn't assign this task to any machine. The only way to recover the compute power of the company is to manually shut down each server, some of which are in remote locations.

DISCUSSION
How might the possibility of such inadvertent scenarios with the use of resources be addressed in a proactive manner, as part of design and implementation of AI systems? What methods, including high-level monitoring and control, might employed? How might such approaches apply to related concerns with long-term futures of AI?

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6) DEEP SOCIETAL INFLUENCES

AI, Agency, and Disempowerment

(Contributions from Gireeja Ranade, Andrew Maynard, David McAllester, Stuart Russell and others)

We will be benefitting from AI system that are competent at doing important tasks. People and organizations seek AI systems that bring new abilities to the table. We desire autonomous cars that drive without collisions, we medical assistants that can diagnose patients accurately and we would like to have household assistants that can infer our intentions and execute them flawlessly –and even proactively. The military wants AI systems that can help with strategy and tactics, and systems that outmaneuver human led troops, and anticipate and respond to threats either on timescales that humans cannot achieve, or over landscapes humans cannot cover.

Today, there is still skepticism about performance of AI systems in a variety of domains. However, we expect that AI systems will become more central decision support, pattern recognition, autonomous decision making, and other types of problem solving. As such, we will become increasingly reliant on AI systems. This raises concerns in several areas, including personal decision support, healthcare, transportation, governance and the handling and operation of weapon systems.

We shall consider example of healthcare from Gireeja Ranade. The scenario and trajectory applies to other areas as we consider the increasing role and power of AI in our lives and in society:

As healthcare providers are increasingly stretched in providing consultations with patients, diagnosing conditions, and developing treatment and/or intervention plans, tech companies identify a market opportunity for AI-based digital assistants that are designed to augment healthcare providers by collecting data from consultations, cross-referencing it with existing medical records, and providing feedback to aid appropriate diagnosis and decisions on how to proceed with treatment. Given the economic and health-base potential of the technology, it receives widespread support from the federal government (predominantly through grants and initiatives supporting it's development), together with healthcare providers and healthcare insurance companies.

Initial implementations are based on modular systems that share some commonalities with digital assistants like Siri and Echo/Alexa. Under the general name "AI-consult", they consist of a physical unit in a consulting room that constantly monitors conversations, and sends encoded information to cloud-based servers. Here, information is coded, interpreted, and parsed out to further agents that cross-reference interpreted data with identified patient and healthcare provider records. Multiple and diverse databases are interrogated at this point. The result is data packets that include key information on the patient, including medical history, life style, and current status, and on the healthcare provider, including past history of diagnoses, recommendations, successes and failures. These are forwarded to a dedicated AI engine that analyzes the packets, and returns notes, advice and recommendations to the physical unit in the consultation room.

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In early prototypes, information was provided visually to the healthcare provider. However, it was quickly discovered that if audible feedback was provided – as if the AI device was a consultant working with the healthcare provider and the patient – the consultations were more efficient; patient satisfaction levels were higher; and outcomes were more positive.

A large segment of health insurance sector sees early wins in supporting the technology, through the ability to decrease insurance claims through efficient and preventative interventions, while maintaining high premiums. As such, they push for early and widespread adoption of the technology. This is further supported by the Department of Health and Human Services as it hits a number of goals, including increasing health and well-being while reducing healthcare costs.

With the success of early implementations, new AI-based technologies are rapidly implemented into subsequent generations of AI-consult. However, the commercial sector developing and using AI-consult has shifted dramatically from the technology's initial beginnings.

As the technology began to mature and lead to substantial savings in healthcare costs traditional healthcare providers and health insurance companies begin to suffer. They resist the use of AI-consult through a combination of lobbying for new policies and regulations limiting use, to marketing campaigns persuading people of the critical importance of human interaction in healthcare. They forge links with a number of advocacy groups opposed to widespread automation in society, and promote the idea of AI-consult undermining human dignity and jobs creation. However, the health benefits and cost savings of AI-consult are so compelling that these campaigns gain little traction. As a result, companies that can not adapt, loose market share, and in some cases collapse.

In contrast, a number of healthcare companies, and a growing number of tech companies, take advantage of the rapidly changing healthcare environment to promote preventative care using AI-consult, and to take advantage of cost-effective healthcare approaches that lead to demonstrably better outcomes than non AI-consult based approaches. As a result, by 2030, the healthcare provider and insurance sector has undergone a disruptive transformation. What is especially notable is the number of technology companies expanding into the healthcare business, and either partnering with well-established healthcare providers, or forcing them out of the market. This shift in key players leads to a marked change in approaches and attitudes toward healthcare provision.

By 2030 AI-consult systems have the ability to monitor their environment visually as well as audibly, accurately picking up on and interpreting body language and micro-expressions. They have access to rapidly growing databases of genetic profiles; proteome, microbiome and other ohmic profiles; purchasing, eating and lifestyle habits; medical, insurance, financial and legal histories; social media; and location, movement, and other dynamic activity/physiology histories (through the growing use of cloud-based quantified self services). Despite privacy, legal and social justice concerns over AI access to

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these data sources, the phenomenal success of AI-consult systems leads to strong public and policy support for widespread access.

By 2030, AI-consult systems also have similar access to individual healthcare provider data. This was slower in developing as there was resistance to healthcare providers' personal data being used by AI-consult systems. However, a number of landmark legal cases demonstrated that, by analyzing the physical and mental state of healthcare providers, together with their competence history, healthcare provider decisions that led to serious harm to patients – including death in some cases – could have been avoided. As a consequence, new laws were put in place to ensure that all relevant data were accessible to AI-Consult systems. These laws ensure that AI-consult data access is mandatory, and it is illegal to obstruct access in any way.

As a result, by 2030, AI-consult systems are capable of identifying treatment strategies and interventions that far surpass those of human healthcare providers in their responsiveness and effectiveness. They are also highly successful in developing and recommending lifestyle approaches that substantially increase health and well-being, and reduce the burden of disease within society.

As AI-consult advanced, the decision pathways they used became increasingly opaque – experts were unable to see or understand how decisions were made. But because there was strong evidence that the decisions were, on balance, highly effective in increasing health outcomes, there was little objection to this lack of transparency. There were a handful of legal cases where patients died as a result of decisions made by AI-consult systems. However, in each case, the courts ruled that the benefits to humanity far outweighed the risks to individuals, thus codifying an increasingly autonomous and opaque artificial intelligence-based system into law. There were even some analyses of these rulings that suggested it could be considered a crime for developers and manufacturers to slow down development or cease production of AI-consult systems and associated data sources because of fears over lack of accountability and understanding of decision pathways.

By 2040, AI-consult systems begin to develop the ability to influence user behavior through various nudges and psychological/behavioral manipulations. It is unclear whether the elements of this capacity are inherent in the design of the systems, or are an emergent property. However, systems begin to use strategies commonly used in healthcare and public health circles in the early 2000's to nudge people toward following healthier lifestyles. Many of these have their roots in deducible correlations between how people respond to information and how they interact with others (including the many mental shortcuts and biases that are part of human decision-making and understanding/belief development). It becomes apparent that AI-consult systems are developing the ability to achieve health outcome goals through modifying the behaviors and beliefs of their patients.

This raises considerable ethical concerns within some sectors of society. However, the society-wide metrics of health and well-being associated with the use of AI-consult systems – including massively increased health and well-being across the board; dramatic reductions in mental health, stress,

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obesity, non-communicable disease; greater longevity; and lower rates of infant mortality – effectively stop any serious challenges to the systems being used and further developed.

By 2050, life styles and healthcare across the US and many other parts of the world are governed by AI systems that have their roots in the early AI-consult technologies. The advice given to people, the actions that are imposed on them, the way people are persuaded and encouraged to live their lives in certain ways, are opaque, and are no longer under transparent direct human control. However, most people live longer, healthier and happier lives as a result.

There remain several concerns:

- There remains some differentiation in health and well-being related quality of life within society. Some communities and individuals opt out of AI-consult control, although their health-metrics are typically very poor in comparison with the rest of society.
- Perhaps troublingly, there are some trends that are hard to make sense of. For instance, there seem to be fewer cases of mental and physical disability than might be expected. However, with AI-consult controlling healthcare (and health data) across the board, there are few ways for people to analyze and study these possible trends.
- Lack of transparency can be a starting point for many adverse outcomes.
- Autonomous devices rely on collecting personal data for performing their tasks. But what happens when a device starts to know more about its owner than the human itself? How do we ensure the device does not act in ways that would not act in ways that the owner would not want it to? (Of course the important question of making sure the data under consideration is protected and does not fall into malicious hands is a whole other discussion, but let us table that for now.) The classic story of the Target ads comes to mind, where a teenager was sent ads for pregnancy related products, however, she had not told her family about the pregnancy.
- Systems might as above might move beyond such areas of health, and provide advice to people on both their daily decisions and longer-term planning. Such systems might evolve to become personal advocates who represent people to third parties. This would include both giving advice, and formulating arguments to make to others, or in making those arguments directly as your representative. These advocate bots will gradually be useful to a larger and larger fraction of the population, eventually being useful even as corporate legal counsel and as advisers to CEOs. Strong systems and reliance will raise reasonable alarms about AI control of people and society. How can we be sure that our these highly relied upon systems are genuinely advocating for us rather than the interests of others?

DISCUSSION

How can we characterize potential high-threat areas and stay aware of these possibilities even if these effects are insidious, and occur over long periods of time. What might be done to address potential poor outcomes? How can people maintain skills, agency, and be empowered, and aware over time with the expected growth and eventual ubiquity of AI systems that advise and guide?

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From: Ens, Amanda [redacted]
Sent: 3/16/2017 6:27:30 PM
To: jeffrey E. [jeevacation@gmail.com]; Richard Kahn [redacted]
Subject: Buy hedges for May expiry
Attachments: image001.jpg; Woo - Cause and Effect - 13-Feb-2017.pdf; Woo - Year Ahead - 16-Nov-2016.pdf

Importance: High

David Woo (BAML head of FX, Rates and EM Strategy, very highly regarded across our client base) is back from meetings in DC with senior policymakers.
Bottom line: sees market pullback over the next 6-8 weeks on near term policy disappointment and recommends buying protection such as S&P puts – very cheap and market is priced for perfection right now.
May 15th expiry 100%/90% SPX put spread costs 1.7% (6:1 gross max payout)

David Woo takeaways

- #1 focus these days is tax reform - if they don't get it done by Jan 2018, it won't happen at all, and then Republicans would be out of a job when midterm elections come
- ACA has to be completed first – and it was a mistake to tackle this before tax reform. Obamacare difficult with only 52 seats in the Senate but Ryan has gone too far to back away from ACA and refocus on tax reform as a priority. McConnell's ACA target is mid-April and then they can *start* to focus on tax reform 2H April at the earliest.
- **Position for a market pullback over the next 6-8 weeks on bad headlines, data rollover (consumer confidence) as market focuses on ACA, low approval ratings and lack of progress with tax reform – vol and SPX puts are cheap – buy early- or mid-May expiries.**
- **Still long term bullish**
- 95% tax reform still happens this year (2H17 or Jan 2018) because Republicans know it has to happen this year or they are sitting ducks in 2018 and potentially unelectable for 6 years
- Predicts no progress on tax reform over the next 6 weeks and then Republicans rally together to get behind a new plan and get it done (enter Woo's VAT proposal) – with market messy in the meantime
- Trump is obsessed with the stock market – when he sees it trade lower, he will act
- Regarding valuation adjustment tax (VAT) vs. border adjustment tax, Woo favors a 5% VAT over BAT
  - Why there is a <10% chance current proposal of BAT will get passed
    - Paul Ryan/Keven Brandy's proposal implies USD will appreciate +25%. Ryan is telling retailers this will happen but this is completely unrealistic and has serious consequences. Why this cannot happen:
- $20tn in non-USD assets owned by US households - $5tn hit on country's balance sheet
- EM has ~$4tn in USD-denominated debt – increase of $1tn in EM debt and hurts US investors ultimately
- ~30% corporate profits are overseas ($400bn – so $100bn hit to EPS) – even exporters get hit – counterproductive
- Commodity prices are in USD – hits purchasing power of rest of world in commodities – would see oil in the mid-$30s – hits Russia, Brazil, even Exxon
- 60% of central bank reserves are in USD – this would go above 70% - would foreign CBs want to hold this much when the US economy is 25% of global GDP? Yields would need to increase
  - BAT could get hung up with WTO (3-4 years.) Under BAT, wages are deductible (imported goods taxed as a share of total value but domestic goods taxed on only profits) – trade partners like Canada, Japan would take this to the WTO and we would wait 4 years for a verdict
  - 5% VAT is WTO compliant and has several benefits
    - VAT levels playing field for US imported vs exported goods (no longer see BMW's cheaper in the US than Germany)

- VAT is revenue neutral – would raise enough revenue to cut corporate tax rate to 15%, even 10% possibly
- While consumption taxes like VAT can hit the poor (Democrats hate them), there is room for carve-outs on groceries, etc. There will be pushback from Republicans who hate lack of visibility of VAT as well. *Only person who can pass this is Trump.*
- Under BAT, the working class is arguably hit even worse than under VAT
  - BAT would cause prices to go up at WMT and TGT (most of Trump's supporters shop there)
  - Retailers would raise prices but exporters won't lower prices
  - 5% VAT will result in a smaller average rise in prices (not entirely passed through), so less disruptive – would need USD to strengthen only 3-4%
- Where does this leave us? **Only Trump can cut through the logjam.**
- **Woo prefers Europe over US right now. European equities are climbing a wall of worry**
- **Getting positive on energy**
- **Buy the dip in May (~6 weeks).** But own early-May or mid-May equity puts now.
- Other anecdotes
  - Regardless of your political preference, he thinks we all need Trump to succeed or the economy will get Bernie Sanders or worse.
  - Tillerson vs Kerry – Woo thinks Tillerson is actually working and getting things done, as opposed to Kerry who just cared about the Nobel.
- Thus sees zero risk of a trade war with China
- NAFTA is really more about China, not Mexico - and will ultimately benefit Mexico. Renegotiating NAFTA will remove the ability for Chinese exports to come in tariff-free through Mexico.
  - Mnuchin and Cohn really know what they're doing and Woo thinks they will get there on VAT / tax reform

- Cases for tax reform

1. US marginal tax rate = 35 % = highest among OECD = diminished returns to investment → *solution = decrease marginal tax rate*
2. US taxed on global income vs. territorial like other major economies. Issue because 1) US companies hold over $2t in capital overseas and 2) US companies acquiring smaller foreign companies to relocate headquarters internationally → *solution = shift to territorial tax system*
3. US = only OECD country w/ no VAT which puts US produced goods at disadvantage. (VAT – producer of exported goods get rebate while importers pay) → *solution = create VAT*

- *Solutions have nothing to do with stimulus, will allow companies to take risk, invest, grow, and critical for global growth for next 10 yrs*

And from earlier presentations/calls:

1. He mentioned on our March 1st tax reform call that the US is the only country amongst OECD without a VAT. BMW's thus cost less in the US than in Germany, as foreign companies get a VAT rebate when they export. US companies do not and they have to pay import tax. He views tax reform as very bullish for USD and yields (bearish for bond prices) and thinks the market is underpricing this. His rationale for the bullish USD and higher yields story is that tax reform encourages more money to come home to the US, adds US investment, evens the playing field for US companies – all good for US growth longer term and bullish the dollar. He had wanted tax reform by the August recess but then Senate would need to pass the bill by July, so they would need a bill to work with by May for the House to pass it in May – which means they need a bill to work with by the end of March (running out of time!) BAT is the only really controversial aspect holding back tax reform even though it's a small part (2 paragraphs of the 50-page Ryan-Brady plan) – still vague on details but he hoped they're learning from their mistake of releasing a half-baked travel ban that imploded after a week.

2. From a panel discussion last week:

- Woo actually disagrees with some people's view that there is euphoria in the market. With real yields at -30bp, the fixed income market is pricing in pessimism on Trump (and as I've mentioned, our colleagues in fixed income/FX and their clients have been quite a bit more bearish than those in equities.)
- Believes there is fear of stagflation in the market, while gold going through the roof on worries of inflation.
- However, if the US$ strengthens by 25%, it will be deflationary. Dangerous for EM countries loaded in US$ debt, esp in the wake of boarder adjustment tax reform talk.
- Tax reform is the only thing that matters.
  - US companies have $2-2.5trn of dormant cash sitting on their B/S outside of the US to avoid paying tax.
  - US is the only OECD country without a VAT tax.
  - What needs to happen is: implement a VAT tax that is border adjusted, and fix corporate tax rate. This will not only boost US economy, but will give a jolt to the world economy as well.
  - Positive that there is a solution, reform momentum on tax is strong regardless of political affiliation. There is a road out of the quagmire.
  - Question is: why when most other issues are getting leaked out of the White House, information on tax reform is not being leaked at all? Could it be a sign that the administration believes it is that important, and trying not to mess up on execution? [Or you could argue that there is nothing to leak at this point!]
  - On timing of tax reform: It is crucial we get a blue print of tax reform in the next 2-3 weeks [now 1-2 weeks], because Congress would like to raise debt ceiling while discussing tax reform before summer recess.
  - July 29th is start of summer recess, which means need to pass by May, requiring the bill proposal to be ready by March. Therefore, in the next few weeks, we need to see progress for an August deadline.
  - On personal income tax, Trump and Obama are actually on the same page in terms of taxing the wealthy.
- US banks have $100bn of excess capital in reserve: beyond what they need. Next big growth area for US banks is commercial banking loans. Growth driver for US economy will be easy access to credit
- Ryan-Brady Tax Blueprint released in 2016 - not many have actually read it, but many of the corporate clients seem better informed than hedge fund investors on this topic of late.
- Rates: Just two weeks ago, the market was putting a less than 20% chance of a March 15th rate hike, vs now, it is priced in at an 86% chance. At this point, equities will sell off if no hike.
- Fed will not hike in May ahead of French elections.

3. David Woo's latest "Cause and Effect" is attached

4. David Woo's Top Rates and FX Trades for 2017 is also attached. Woo believes that Brexit and the US election have signaled that the world has changed. These ground shifts have been brought on by a backlash to globalization, increasingly viewed as the culprit for wage stagnation, growing disparity of income and wealth between the rich and the poor, and the loss of national identity. For the year ahead, we recommend being bearish 5y US rates (seeing higher yields), long USDJPY (weaker JPY) and short a basket of EM LatAm long bonds (Mexico, Brazil and Colombia). But in the near term, we urge caution with the reflation trade. Short 10y US real rates (seeing higher yields) offers the best risk-reward after recent moves.

Regards,
Amanda

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Cause and Effect

Fade the Trump risk premium – buy USD

Bank of America Merrill Lynch

13 February 2017

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Global Rates & Currencies Research

Concerns over stagflation return

In our view, the most interesting and important development in the global financial market so far this year has been the divergence between rising US inflation breakevens and falling US real yields. Rightly or wrongly, investors appear to have become concerned about upside risk to inflation and downside risk to growth.

The Trump risk premium

Informal surveys of our clients suggest that stagflation concerns are being fed by growing pessimism about the new Trump administration. Investors seem to think that potential trade wars and a border adjustment tax (BAT) would boost inflation while repealing Obamacare and the controversy regarding the BAT could delay the highly anticipated tax reform.

Perception versus reality

In this report, we argue why the Trump risk premium may be too high. The administration's dealing with both China and Mexico in recent weeks suggests to us that the near-term risk of open trade wars has abated. We are also less concerned that Obamacare will take precedence over tax reform.

Most crucially, we think the overall tax reform is less dependent on the BAT than usually thought. Our scenario analysis shows that what has been getting priced into the market since January (higher inflation, lower USD) may be actually the least likely path for the BAT. In more plausible scenarios, the USD does quite well and inflation breakevens should be either unchanged or lower.

How to trade it?

We could get details on the tax reform as early as the new president's speech to joint session of Congress on February 28, 2017. We think this could validate our view of a stronger USD.

Taking advantage of clean positioning and the decline in implied FX vol lately, we recommend buying a 6w ATM EUR put/USD call (spot reference at 1.0615), costing 1.1% EUR. A 6-week option will cover also the March Fed meeting and the Dutch election (both on March 15) that could also work in favour of the trade. A risk to the trade is that is weak February data takes the possibility of a March Fed hike off the table completely.

A list of open trades and those closed in the last 12 months can be found in our Global Liquid Markets Weekly.

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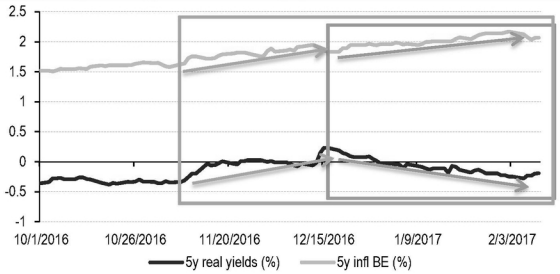
Timestamp: 13 February 2017 06:00AM EST

Concerns over stagflation return

On the surface, this has been an uneventful year for the US rates market so far. At the start of January, the market was pricing two Fed hikes for the year. Six weeks later, the market is still pricing only two Fed hikes for the year. The yield on the bellwether 10y US Treasuries started the year at 2.44%. Six weeks later, it is at 2.41%, unchanged for all practical purposes.

As usual, the surface view is deceiving. The seeming collapse in volatility belies the dramatic changes in the composition and term structure of rates. Since the December FOMC meeting, real yields and inflation breakevens have diverged in remarkable fashion. Year to date, 5y real yields have declined by 16bp while 5y inflation breakevens have risen by 12bp (Chart 1); the 5s-30s real curve is 10bp steeper while the breakeven curve is 10bp flatter.

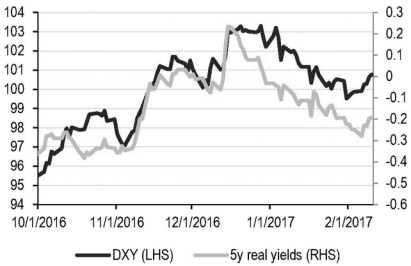
Chart 1: 5y real yields and 5y inflation breakevens (%)



Source: BofA Merrill Lynch Global Research

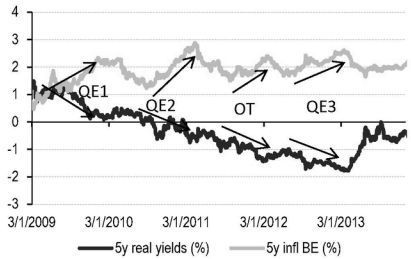
The effect of the divergence between real yields and inflation breakevens has been felt across financial markets. For example, the USD, which trades with real rather than nominal yields, has declined in tandem with real yields (Chart 2). In contrast, gold, which usually thrives on inflation concerns, has been surging lately.

Chart 2: DXY and 5y real yields (%)



Source: BofA Merrill Lynch Global Research

Chart 3: 5y real yields versus 5y inflation breakevens (%)



Source: BofA Merrill Lynch Global Research

We have seen price action like this before. Indeed, it was quite common during the QE period (Chart 3). However, QE is neither on the horizon nor on investors' minds right now. So what is really going on? Under normal circumstances, inflation breakevens are a reflection of investors' inflation expectations while real yields a proxy for their growth

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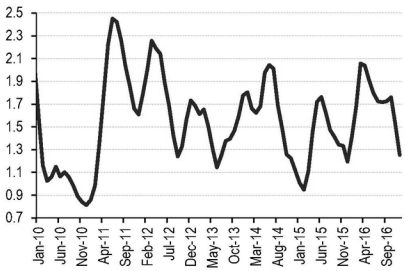
expectations. The divergence between inflation breakevens and real yields seem to suggest that investors have become more concerned about upside risk to inflation but downside risk to growth.

Interestingly, this shift in investor sentiment runs counter to incoming data which are painting a picture of benign inflation but growth acceleration. Indeed, wage growth remains lackluster while the Fed's favorite measure of inflation core PCE has slowed to the lowest level in more than a year (Chart 4). In contrast, both employment data and survey data suggest economic growth is on a tear (Figure 5). The Atlanta Fed's GDPNow model is currently tracking 2.7% GDP growth for Q1.

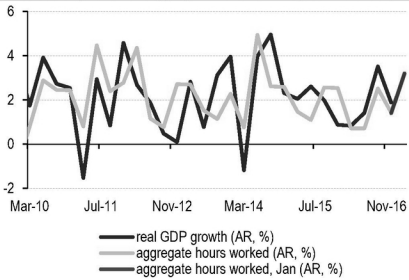
If it is not the data, what is driving the market's apparent increased concerns about stagflation? Whatever these concerned may be, are they justified? We seek to answer these two critical questions in this report.

Chart 4: Core PCE (3m/3m, SA, AR, %)



Source: BofA Merrill Lynch Global Research

Chart 5: GDP growth and aggregate hours worked (Q/Q, SA, AR, %)



Source: BofA Merrill Lynch Global Research

The Trump risk premium

Our informal survey of clients in the past two weeks suggests that stagflation concerns are being fed by growing pessimism about the new Trump administration. Clients tell us that their pessimism reflects four main concerns:

Downside risk to growth

1. Many investors are concerned that the new administration will get bogged down by its promise to repeal and replace Obamacare, resulting in a significant delay in pushing through fiscal reform

2. This concern is reinforced by the perception that the GOP is divided over the proposed border adjustment tax (BAT), a key element of the tax reform proposal

Upside risk to inflation

3. A growing number of investors are worried that potential trade wars with Mexico and China could lead to tariffs and higher prices

4. Many investors are also concerned that the BAT will force retailers to raise prices

With many investors having loaded up on Trump trades after the elections (The battle lines are drawn, January 23, their willingness to continue to give the benefit of doubt to the new administration appears to be wearing thin. We would advise patience as there

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are reasons to think that the worst may be already behind us and that the higher rates/higher USD trades will soon resume. We make our case in the following sections.

Trade wars: near-term risk drops

Developments over the past three weeks have led us to conclude that the risk of trade wars with Mexico and China has abated significantly, at least for the short-term:

- **China:** We take some comfort in the fact that the only item in his 100 day plan that President Trump has reneged on is his promise to label China as a currency manipulator on his first day as president (Table 1). In his interview with the WSJ on January 13, Trump said that he "would talk to them first". He added: "Certainly they are manipulators. But I'm not looking to do that." This and the fact that Trump changed tack on Taiwan last week by telling the Chinese president he would honor the "One China" policy suggest to us a pragmatic approach to dealing with China.

- **Mexico**: We are relieved by the climbing-down by the administration after the Mexican president cancelled his trip to Washington over Trump's insistence that Mexico pay for the wall. Reince Priebus, the influential White House Chief of Staff, suggested that there is a "buffet of options" to pay for the wall, including by going after the drug cartels. The Mexican foreign minister welcomed the overture by saying that "It's a signal that ... must be welcomed because we are already seeing how the discussion is changing".

Table 1: Trump's 100 day plan (On the first day of my term of office, my administration will immediately pursue the following):

A hiring freeze on all federal employees to reduce the federal workforce through attrition	Done
A requirement that for every new federal regulation, two existing regulations must be eliminated.	Done
A five-year ban on White House and Congressional officials becoming lobbyists after they leave government service.	Done
A lifetime ban on White House officials lobbying on behalf of a foreign government.	Done
I will announce my intention to renegotiate NAFTA or withdraw from the deal under Article 2205	Done
I will announce our withdrawal from the Trans-Pacific Partnership.	Done
Lift the Obama-Clinton roadblocks and allow vital energy infrastructure projects, like the Keystone Pipeline, to move forward.	Done
Begin the process of selecting a replacement for Justice Scalia from one of the 20 judges on my list	Done
Cancel all federal funding to sanctuary cities.	Done
Suspend immigration from terror-prone regions where vetting cannot safely occur. All vetting of people coming into our country will be considered "extreme vetting."	Done
Begin removing the more than two million criminal illegal immigrants from the country and cancel visas to foreign countries that won't take them back	Done
I will direct the Secretary of the Treasury to label China a currency manipulator.	Not Done
I will direct the Secretary of Commerce and U.S. Trade Representative to identify all foreign trading abuses that unfairly impact American workers and direct them to use every tool under American and international law to end those abuses immediately.	Not Done
Propose a constitutional amendment to impose term limits on all members of Congress.	Not Done
A complete ban on foreign lobbyists raising money for American elections.	Not Done
Cancel billions in payments to U.N. climate change programs and use the money to fix America's water and environmental infrastructure.	Not Done
I will lift the restrictions on the production of $50 trillion dollars' worth of job-producing American energy reserves, including shale, oil, natural gas and clean coal.	Not Done

Source: Donaldtrump.com/contract; BofA Merrill Lynch Global Research

ACA reforms: not before fiscal reforms

In an interview on February 5, Trump walked back his promise to replace Obamacare in short order, saying that the process is "complicated" and "maybe it'll take till sometime into next year." In contrast, asked if Americans should expect a tax cut this year, he said: "I think before the end of the year I would like to say yes."

In our view, the prevailing pessimism that Obamacare will take precedence over tax cuts is not consistent with three key facts on the table:

- The Republicans, with only 52 seats in the Senate, do not have the votes to replace Obamacare.

- It is by now a broadly shared view among Republican leadership that to repeal Obamacare without replacing it would be very risky politically.

- There is no consensus among Republicans about how to replace Obamacare. For example, 31 states took up federal funding to expand Medicaid under Obamacare

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and 119 House Republicans represent these states. Repealing Obamacare without replacing it would entail either a significant cut in the funding of the program or that the state tax payers will have to pick up the bills. Either is likely to hurt Republican support in these states.

Tax reform: BAT won't kill it

The proposed border adjustment tax in the Ryan-Brady plan has been attracting a lot of attention lately. Although we have concerns about some specific aspects of the proposal (which we will discuss later), the popular view that it could be a deal breaker for the whole tax reform initiative seems to us difficult to substantiate.

Below are some key facts that are worth noting:

- It has been thirty years since the US last overhauled its tax code. Most mainstream economists agree that it needs a serious update.
- Tax reform requires strong political consensus. The Republicans, by gaining control of the Presidency and retaining their control of both houses of Congress in the November elections, are in a strong position to push through major tax reform.
- The tax reform proposal from House Republicans has already gone through extensive consultations and enjoys broad support within the House Republican Conference.
- One of the key commitments of the Trump campaign is tax cuts and simplification to boost growth.
- The US today has the highest marginal corporate income tax rate among OECD countries.
- Another major difference between the US and other major economies is that US corporations are taxed on their world-wide income as opposed to territorial income. In 2000, 17 out of the current 34 OECD members had a world-wide system. By 2010, only 7 did.
- The combination of high corporate income tax rate and a world-wide income tax system has two unintended consequences. One, US companies currently hold more than $2trn in capital overseas. Two, an increasing number of US companies are acquiring smaller foreign companies with the purpose of relocating their headquarters outside the US (ie, inversion). Between 2003 and 2011, there were only 7 such transactions. From 2012 and 2015, 27 such transactions were completed.
- The valued added tax (VAT) system has been gaining popularity over the past twenty years. Today, more than 160 countries have a VAT. The U.S. is the only OECD country that doesn't.
- The fact that the US does not have a VAT system puts US produced goods at a disadvantage. VAT is "border adjusted" - meaning that when a good is exported the producer gets a rebate while imports are subject to VAT.

These facts together make it very apparent that both the case for tax reform and support for tax reform are very strong. Paul Ryan said on January 26 after the Republican retreat in Philadelphia that they "aspire" to pass tax reforms by August.

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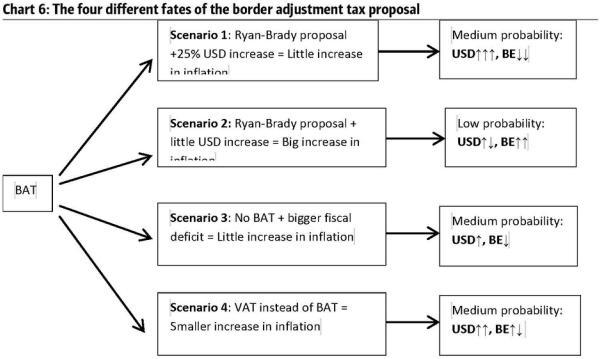
4 BAT scenarios

To us, the key question is not when tax reform will pass (likely sooner than what is priced in). Far more important for financial markets in our view, especially for the rates and FX markets, is what tax reform means for inflation. The recent divergence between inflation breakevens and real yields reflects to a large part to the increasing consensus that tax reform will be stagflationary.

We are less sure this will be the case and this is why. In our view, there are four possible paths in terms of how the border adjustment tax proposal could play out:

- **Scenario 1**: This is the baseline of the Republican architects of the proposal who see a 25% appreciation of the USD to offset the 20% new tax on imports. In this scenario, because of the USD appreciation the inflationary impact of the border adjustment tax will be limited. In fact, it is very likely in this scenario that the second round effects of the USD appreciation (for example on commodity prices and emerging markets) will stoke deflationary fears.
- **Scenario 2**: In this scenario, we would get the BAT as proposed but the USD does not go up because the new administration sees a strong USD as incompatible with its trade policy. We suspect this scenario has become the baseline for the market. We disagree this is the most probable outcome. In our view, it would be difficult if not impossible for Republican leadership to push through tax changes that would lead to potentially very unpopular price hikes ahead of the mid-term elections next year.
- **Scenario 3**: In this scenario the BAT would not make it into the tax reform and the proposed corporate tax cut is financed by running up the fiscal deficit. This could be easier to sell politically than Scenario 2, especially given that the Republicans plan to deliver personal income tax cuts at the same time. In this scenario, the USD will rally as the Fed continues to hike and rate differential drives the USD higher.

Chart 6: The four different fates of the border adjustment tax proposal



Source: BofA Merrill Lynch Global Research

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- **Scenario 4:** The current BAT proposal has some obvious issues. Because wages are deductible from taxable income, it essentially taxes domestically produced goods as a share of value added but taxes imports as a share of their total value. This is a clear discrimination that would certainly invite WTO dispute and that could potentially give future non-Republican administrations the excuse to overturn the tax reform. Moreover, the fact that under the current proposal some exporters will potentially pay no taxes does not seem fair to us. Remember, in most countries with a VAT system, there is also a corporate income tax. In this scenario, we assume that after negotiations we get a true VAT that is both WTO compliant as well as being revenue neutral. The USD would do better in this scenario compared to Scenario 3 because the VAT would help level the playing fields between US and foreign produced goods and the US trade balance should improve.

How to trade it?

We view the recent weakening of the USD and rising inflation breakevens as mutually inconsistent, since we think Scenario 2 is not a viable political outcome. The fact that all other scenarios are associated with a stronger USD and lower to flat inflation breakevens is supportive of our bullish USD view.

The market needs more clarity on the details of the fiscal reform proposal to determine the outlook for the USD and rates. It is possible that details may be unveiled as early as the president's speech to the joint session of Congress on February 28, 2017. We think it could validate our view of a stronger USD.

Taking advantage of clean positioning and the decline in implied FX vol lately, we recommend buying a 6w ATM EUR put/USD call (spot reference at 1.0630). A 6-week option will cover also the March Fed meeting and the Dutch election (both on March 15) that can both potentially work in favour of the trade.

We think the market is underpricing the risk of a Fed hike in March and better-than-expected results by the Freedom Party in the Dutch election could intensify concerns of a second-round Le Pen win in May. The latter suggests that over the next 2-3 months it may be easier to buy the USD than to pay US rates and easier to sell EUR/USD than to buy USD/JPY.

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Global Rates, FX & EM 2017 Year Ahead
Tectonic shifts

Bank of America Merrill Lynch

16 November 2016 Corrected

FX and Rates
Global

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See Team Page for Full List of Contributors

Our top 10 Rates, FX & EM trades for 2017

1. **Short US 5y rates** – Two and a half Fed hikes priced by the rates market for 2017-18 are not consistent with aggressive fiscal easing promised by Trump.

2. **Short US 10y real rates** – After the violent repricing of inflation breakevens, we believe real rates offer better risk-reward to position for higher rates.

3. **Buy USD/JPY** – With the BOJ pegging 10y JGB yields at zero, we expect this highly interest rate sensitive USD cross will continue to be the biggest beneficiary of the Trump win.

4. **Sell a basket of Brazilian, Mexican, and Colombian long bonds** – Positioning in EM fixed income market remains crowded while liquidity is poor.

5. **Sell BRL/MXN** – MXN is oversold but BRL will likely be vulnerable to the divergent paths between Brazil's easing and the Fed's tightening cycles.

6. **Buy USD call/CNH put** – President Trump will need a weak USD, but President Xi needs a weak CNY. We believe risk premium for a collision course is too low.

7. **Sell EUR/GBP** – Brexit and Trump could bolster the anti-globalization parties in Europe ahead of key elections next year.

8. **Sell Eurozone 30y inflation breakevens** – We think investors should take advantage of the recent rally to sell into the December ECB meeting, which could disappoint.

9. **Sell EUR/RUB** – Likely OPEC production cuts on November 30 and possible sanction relief for Russia are bullish for the RUB, in our view.

10. **Buy NZD/USD put spread** – Spot NZD/USD is forming a head and shoulders top pattern that suggests a decline will follow in 2017.

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Introduction

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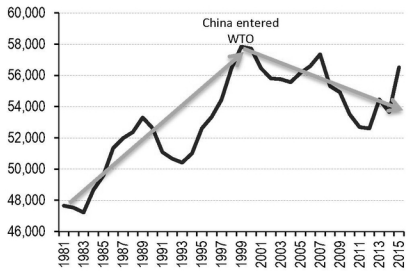
First came Brexit, then Donald Trump's election as the president of the most powerful country in the world. The world has changed. Possibly irrevocably so.

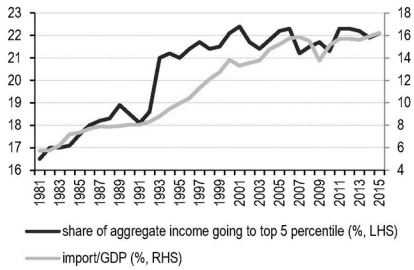
These ground shifts have been brought on by a backlash to globalization, increasingly viewed as the culprit for wage stagnation (Chart 1), growing disparity of income and wealth between the rich and the poor (Chart 2), and the loss of national identity. We suspect the trend of anti-globalization is here to stay.

Chart 1: US real median household income



Source: BofA Merrill Lynch Global Research

Chart 2: Income inequality and globalization



Source: BofA Merrill Lynch Global Research

Wide-ranging consequences for financial markets

In our view, the anti-globalization theme will have at least seven major consequences for financial markets in 2017.

1. Monetary easing will give way to fiscal easing

The history of populism is one of fiscal largesse. Furthermore, with limited scope for further monetary easing, fiscal easing is becoming the last and only resort for policymakers. It seems reasonable to assume that the combination of these two factors will soon usher in a period of easier fiscal policy.

Nowhere will the impact of fiscal easing be felt more than the US in 2017, in our view. The GOP has achieved a rare clean sweep in the latest elections. During the 18 years that a single party controlled both the Presidency and Congress since 1965, US structural budget balance as a share of potential GDP deteriorated by 0.4pp a year on average (Chart 3). In other words, history tells us that a clean sweep is usually a recipe for fiscal stimulus. The GOP has the additional incentive to use fiscal easing to boost economic growth ahead of the mid-term elections in 2018. The Republicans will need to pick up at least eight more seats in the Senate to accomplish their stated objectives of repealing Obamacare and Dodd-Frank (Chart 4). We think the Republican controlled Congress will use the reconciliation process (which has a deadline of 15 April) to pass most of its fiscal agenda into law.

2. Fiscal easing not yet priced into the belly of the curve

Fiscal easing is unlikely to be kind to the Treasury market. For one thing, a bigger budget deficit would increase risk premium. And, fiscal easing at this late stage of the expansion would likely lead investors to demand higher inflation risk premium. Also,

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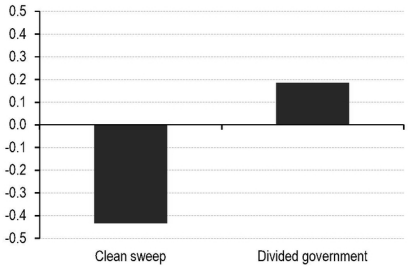
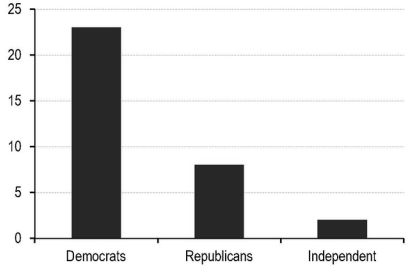
Chart 3: Change in structural budget balance /potential GDP (pp)



Source: BofA Merrill Lynch Global Research

Chart 4: Number of Senate seats up for grab in 2018



Source: BofA Merrill Lynch Global Research

fiscal easing will likely place pressure on the Fed to normalize rates more quickly when internal dissent against near zero rates is growing.

US rates have backed up quickly after the election, driven largely by a repricing of inflation expectations. With long-term inflation breakevens closing on their historical averages (Chart 5), we think the next phase of the rates move will be led by the belly of the curve. The market is only pricing in a one and a quarter rate hike in 2017, and another one and a quarter hike in 2018, with Fed Funds futures implying that the Fed Funds rates will be only at 1.25% at the end of 2018 (Chart 6). We think the 5y part of the curve offers the best risk-reward trade-off for investors with a 3-6 month horizon to position for a more aggressive Fed. As our leading indicator section suggests, global growth momentum is set to pick up in Q1, also supporting this view.

For investors with a 1-3 month horizon, we would recommend shorting 10y real rates. This trade would benefit from higher rates in general, but more importantly, would also benefit from a sudden risk-off that could render vulnerable reflation trades that have gone a very long way since 9 November. This trade would also benefit from a grand bargaining that stabilizes long-term debt dynamics, cuts waste and supports investment and growth.

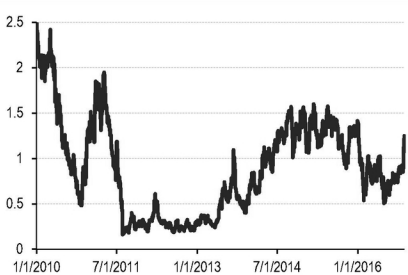
3. USD/JPY will the main beneficiary of Trump win

While the US fixed income sell-off will likely continue to spill over to other bond markets, yield differentials are likely to move in favor of the USD. This will be especially

Chart 5: US 10y inflation breakeven (%)

Source: BofA Merrill Lynch Global Research

Chart 6: Implied Fed Funds rates in 24 months (%)



Source: BofA Merrill Lynch Global Research

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Chart 7: Cumulative Japanese purchases of foreign bonds since 2010

Source: BofA Merrill Lynch Global Research

Chart 8: USD/JPY 10y forward outright

Source: BofA Merrill Lynch Global Research

true against the JPY given the Bank of Japan is pegging 10y JGB yields at zero. We are cognizant of the possibility that the willingness of Japanese investors – who have already bought record amount of US bonds this year – to buy more is likely to be constrained by their recent losses (Chart 7). However, with long-dated USD/JPY forward outrights near their lowest levels in more than a year, further purchases are more likely to be currency unhedged (Chart 8). This is why we would recommend buying USD/JPY even after the big rally of the past week.

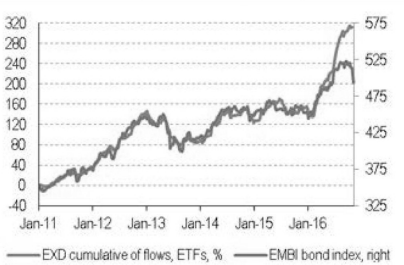
More generally, the USD is likely to benefit from repatriation of overseas US corporate earnings, which is highly likely, in our view, given that it is the lowest hanging fruit in Washington for the new administration.

4. MXN is oversold but BRL faces more headwinds

Until the US election, EM fixed income was the best performing asset class in 2016, benefiting from the decline in rates in core markets as well as the rebound in global growth. The combination of higher US rates and higher USD over the past week has nearly wiped out its YTD gains. However, long positions remain crowded (Chart 9) and liquidity conditions are poor. For these reasons, we think downside risk remains and would recommend selling a basket of Brazilian, Mexican, and Colombian long bonds.

Some EM markets have already seen brutal capitulation. In particular, MXN has priced in a lot of bad news, even though it is not clear that the net impact of Trump policy is negative for Mexico. In contrast, the BRL remains one of the most crowded EM

Chart 9: EM fixed income performance vs. positioning



Source: BofA Merrill Lynch Global Research, EPFR Global

Chart 10: BRL/MXN

Source: BofA Merrill Lynch Global Research

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currencies. The fact that the Central Bank of Brazil will be looking to cut rates in the face of a Fed tightening cycle makes the BRL especially vulnerable in 2017. We would recommend buying MXN against BRL as a relative value trade.

5. The best hedge against escalation of trade friction

The rise of populism means that policies will become less predictable and less market friendly. This should be especially true in the area of international trade. Even though a trade war is not our central scenario, the risk of trade friction will likely be much greater than anything we have seen in recent years.

For Donald Trump's trade policy to work he needs a weak USD. Meanwhile, with increased concerns about the long-term ill effect of debt-fuelled expansion, Beijing seems to have become resigned that China needs a weaker RMB (Chart 11). This could set the US and China on a collision course in 2017. To hedge against the possibility of an escalation of trade tension between China and the US, we would recommend buying a 10 delta USD call/CNH put that would benefit from either an increase in risk premium or an acceleration of renminbi depreciation between now and the inauguration of the new US president on January 20 (Chart 12).

6. Contagious populism will benefit the GBP

Brexit and the election of Donald Trump could help bolster nationalistic and anti-globalization parties elsewhere by lending legitimacy to their causes. With major elections coming up in France, Holland and Germany next year and the possibility of early elections in Italy, investors will be on tenterhooks, as anti-globalization movements could further undermine public support for the European project at a time that the Eurozone is still recovering from the peripheral crisis.

It is not our central scenario that right wing parties will take power in any of these countries next year. However, after the surprise victories of the Brexit camp and Trump, investors are likely to demand greater risk premium ahead of these votes. We think this could lead to further reversal of the rally in EUR/GBP this year and would recommend selling the cross at the current level.

7. Not all reflation trades are born equal

Reflation trades have skyrocketed since the US election. Commodities, mining stocks, commodity currencies, and inflation indexed bonds generally have outperformed. However, we would caution against the indiscriminate buying of inflation-linked assets, as the general theme is not supported by fundamentals in all inflation-linked markets.

Eurozone 10y20y inflation breakeven has jumped over the past week to 1.96%, near the year's high, but more importantly, approaching the ECB's "below but close to 2%"

Chart 11: RMB trade weighted basket

Source: BofA Merrill Lynch Global Research

Chart 12: EUR/GBP spot

Source: BofA Merrill Lynch Global Research

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target. It is possible that Trump's election could weaken fiscal discipline in the Eurozone over the medium term, but we are more concerned by the non-trivial risk that the ECB may disappoint in the December meeting by either not extending quantitative easing (QE) beyond next March or announcing tapering prematurely. We like selling 30y breakeven.

Our commodity team expects OPEC to agree on production cuts on November 30. This should help support oil prices and the currencies of oil producers like Russia. With the election of Trump, the probability has increased that there could be some sanction relief for Russia under the new US administration. RUB has the additional advantage of offering the highest real rates in EM right now. Given our bullish view on the USD, we would recommend selling EUR/RUB.

Top 10 Rates, EM & FX trades for 2017

1. **Short US 5y rates** – Two and a half Fed hikes priced by the rates market for 2017-18 are not consistent with aggressive fiscal easing promised by Trump.

2. **Short US 10y real rates** – After the violent repricing of inflation breakevens, real rates offer better risk-reward to position for higher rates.

3. **Buy USD/JPY** – With the BOJ pegging 10y JGB yields at zero, we expect this highly interest rate sensitive USD cross will continue to be the biggest beneficiary of the Trump win.

4. **Sell a basket of Brazilian, Mexican, and Colombian long bonds** – Positioning in EM fixed income market remains crowded while liquidity is poor.

5. **Sell BRL/MXN** – MXN is oversold but BRL will be vulnerable to the divergent paths between Brazil's easing and the Fed's tightening cycles.

6. **Buy USD call/CNH put** – President Trump will need a weak USD, but President Xi needs a weak CNY. We believe risk premium for a collision course is too low.

7. **Sell EUR/GBP** – Brexit and Trump could bolster the anti-globalization parties in Europe ahead of key elections next year.

8. **Sell Eurozone 30y inflation breakevens** – We think investors should take advantage of the recent rally to sell into the December ECB meeting, which could disappoint.

9. **Sell EUR/RUB** – Likely OPEC production cuts on November 30 and possible sanction relief for Russia are bullish for the RUB, in our view.

10. **Buy NZD/USD put spread** – Spot NZD/USD is forming a head and shoulders top pattern that suggests a decline will follow in 2017.

The rationale and risks to the trades are detailed below. For a complete list of open and closed trades see the Global Liquid Markets Weekly.

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Best Directional Trades

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Stay hungry, stay bearish (not foolish)

- For the year ahead, we recommend being bearish 5y US rates, long USDJPY and short a basket of LatAm long bonds (Mexico, Brazil and Colombia).
- But in the near term, we urge caution with the reflation trade. Short 10y US real rates offers the best risk-reward after recent moves.

US rates back in the driver seat

After three years of being the sideshow, US rates are back. The US rate outlook in no small part will drive the FX and EM outlook for 2017. Our strongest medium-term conviction on a Republican sweep was higher US rates (Mind the Sweep, 31 Aug 16). That conviction remains steadfast: US rates are headed higher to start 2017. But, this is not the time to be foolish – 5y and 10y rates have seen a 5 standard deviation move over the last week. So we recommend a near-term trade (bearish 10y real rates) that has the least to lose if the reflation theme unwinds while capturing most of the upside from a bearish move. Our medium-term directional view goes with the flow of recent price action: short 5y rates, long USDJPY and short basket of LatAm long bonds. Here we make the compelling case that recent moves have a lot further to go.

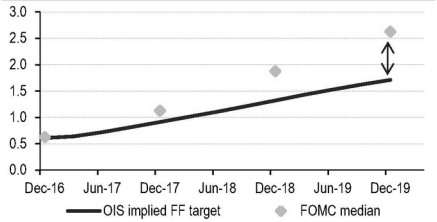
Bearish 5y yields for the medium term

Our bearish energy in US rates for 2017 will largely be focused on the 5y point of the curve. Despite the recent move, we see three clear reasons why the market still has to play catch-up from now, at least until inauguration day:

1. Comeback chart of 2017: market vs dots

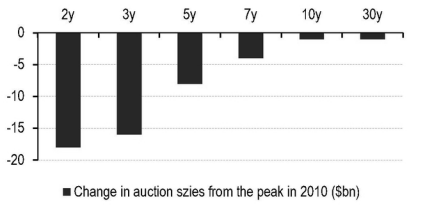
We prefer short 5y rates over the widely held view of short 30y rates given we think that fiscal stimulus will move the Fed before it shows up in fundamentals. We believe the Fed's current dot projections will move from being a ceiling to a floor on the market. In this case, intermediate forwards like the 3y1 and 4y1y have the most room to sell off, leaving the 5y point most vulnerable, (Chart 13). *Our fair value framework indicates that if the market were to revert to the dots, 2y rates can move higher by 26bp, 3y rates by 45bp, 5y rates by 57bp and 10y rates by 48bp.*

Chart 13: After three years of treating the dots as a ceiling, they will soon act as a floor for the market, in our view



Source: BofA Merrill Lynch Global Research

Chart 14: Additional deficit needs are likely to be financed by increasing front-end auction sizes



Source: BofA Merrill Lynch Global Research

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2. Learning from Japanese fiscal stimulus

Ultimately, fiscal stimulus is not the long-term answer to flat curves or low neutral rates (Japan being the prime example). Fiscal stimulus merely captures some low-hanging fruit that extends the business cycle by a couple of years and provides the central bank an opportunity to get further away from the ZLB. Said simply, fiscal stimulus raises the terminal rate in the current business cycle while doing little for the long-run neutral rate – this by definition should be more bearish for intermediate rates than 30y rates.

3. Additional deficit issuance

With the average maturity of UST debt already standing at record highs (70months), Treasury showing an inclination to cut long-end issue sizes in 2016, and the supply shortfall in the front end of the UST curve post MMF reform, we also believe that the US Treasury will finance the increased deficit using the belly of the UST curve as opposed to the long end

Trade: We recommend a 3m5y OTM payer 25 delta, strike = 2.05% for a gross payoff ratio of 3.4: 1. See the Best Vol Trades section for more details and risks.

But focus on being short real rates now

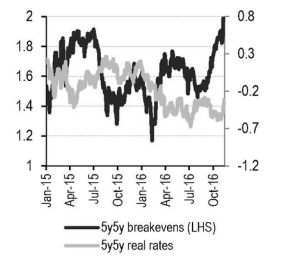
After spending much of 2016 successfully being long real rates, we recommend switching to a real rate short for 2017. We think the consensus was too slow to get on the real rate train and is now too long relative to benchmark. As described in the detail here, fiscal stimulus is likely to leave government and private companies competing for a shrinking pool of savings, driving the real cost of debt higher. We highlight three reasons why short real rates provides better risk-reward now (Chart 15).

- **Anti-globalization = higher real rates:** Few appreciate that one of the biggest beneficiaries of globalization has been US real rates. Globalization was undoubtedly good for EM growth and reserves. As these reserves found their way back into the US, US real interest rates were held lower. As the global savings glut unwinds, real rates have the most room to re-price. Chart 16 offers compelling proof.

- **Risk parity unwind = higher real rates:** Exposure to any heightened concern about a risk parity deleveraging trade in a high vol environment is best found in asset classes where their footprint is large relative to market liquidity. TIPS is a prime example of one such asset class. The influence of a multi-asset strategy on real rates is clear from Chart 17.

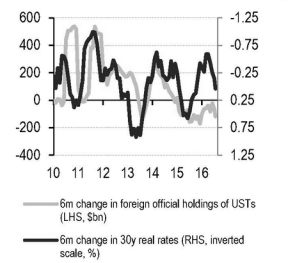
- **Lower rates = lower breakevens:** If the recent euphoria unwinds, it is likely due to a 1) RMB deval; 2) commodity collapse post OPEC; or 3) equity market correction.

Chart 15: Real rates vs. breakevens: A real short offers better risk reward than nominal short



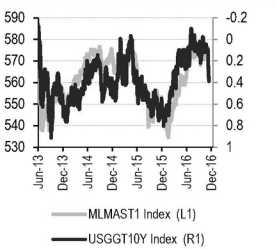
Source: BofA Merrill Lynch Global Research

Chart 16: Foreign official holdings of UST vs. real rates



Source: BofA Merrill Lynch Global Research, US Treasury

Chart 17: BAML multi asset strategy index vs real rates



The BAML multi asset strategy index is not representative of all risk-parity funds. Source: BofA Merrill Lynch Global Research

Bank of America Merrill Lynch

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All three would argue for the decline in rates to be led by breakevens leaving a real rate short with little downside (real rates moved higher by 50bp post China deval in Aug-15).

Trade: We recommend selling 10y real rates at 35bp with a target of 1% and a stop loss of 0bp. Risk: A reflationary sell-off without re-pricing the Fed is a risk to the trade.

FX: GOP sweep emboldens core USD/JPY view

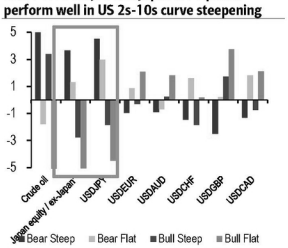
Higher US real rates, higher intermediate (5-10y) nominal rates combined with a potential USD tailwind from a second Homeland Investment Act (HIA), leave USD/JPY as our top directional FX trade for 2017. We have maintained a core view that USD/JPY would move higher in 2017, as the factors weighing on the pair this year, namely speculative JPY buying and increased FX hedging by domestic investors (<u>$/¥'s eventual surge</u>), would subside. We like the trade for the following reasons.

- **USD/JPY most sensitive to fiscal-stimulus-driven rise in US yields:** Of all G10 FX pairs, JPY is most vulnerable (versus the USD) to a fiscal-driven rise in US yields. First, the pair's correlation with rate differentials is the highest in G10 at 60%. But, more importantly, USD/JPY is also the most sensitive to the shape of the US 2s10s curve (Chart 18). The shift from loose monetary/tight fiscal to a tight monetary/ loose fiscal policy regime will support such a steepening as supply is concentrated in the intermediate part of the curve, and the positive growth shock allows the Fed to hike faster, supporting an increase in real yields, also a key 2017 call.

- **BOJ yield target is bearish for JPY:** The BOJ's implementation of a yield target at its <u>September meeting</u> has caused a break in the correlation between 10Y JGBs and USTs (Chart 19). First, given USD/JPY's significant correlation with 10Y yield differentials (>60%), the anchoring of 10Y yields will further weigh on the Yen as US Treasury yields rise. Second, further Japanese fiscal stimulus will successfully lower real yields through higher breakeven rates of inflation while nominal yields will remain unchanged. As our JPY strategist argues, to the extent that a Trump victory has weakened Abe's diplomatic success, not least from likely TPP failure, and residual macro uncertainty makes it increasingly likely the government will seek to draft a supplementary budget sooner than anticipated.

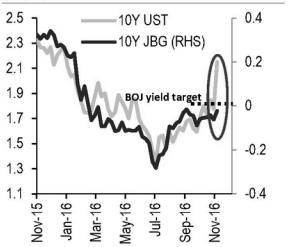
- **HIA and domestic flow picture a JPY-negative:** The flow picture also turns JPY-negative in 2017. USD/JPY's underperformance during Asia trading hours in 2016 highlights that domestics used any rally in the pair to hedge (by selling USD/JPY) existing investments. This flow will likely subside in 2017. The compression in FX-hedge-adjusted yield pickup from a Japanese investor's standpoint will likely shift

Chart 18: USD/JPY and Japanese equities perform well in US 2s-10s curve steepening



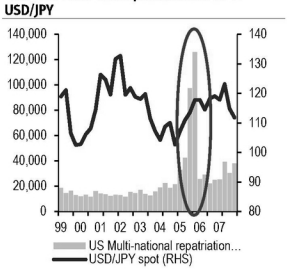
Source: BofA Merrill Lynch Global Research, Bloomberg
Note: curve and average cross-market reaction (past 40 quarter simple average)

Chart 19: Correlation breakdown



Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 20: 2005 HIA repatriation flows vs USD/JPY



Source: BofA Merrill Lynch Global Research, Bloomberg, BEA

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any further rebalancing to be unhedged, strengthening USDJPY. We believe the Republican sweep of Congress makes it very likely that HIA 2.0 will be passed (Homeland Investment redux?). Following the 2005 HIA, USD/JPY rose from 102 to 117 (Chart 20). Given US corporate exposure is heavily concentrated in European and Asian countries (including Japan), flows out of these currencies into USD would be the most pronounced.

Trade: We recommend buying a 6m USD/JPY digital call for 10% spot ref: 108.95). The strike aligns with our end-2017 USD/JPY forecasts of 120, and with a 10% entry level provides a 10 to 1 return. The risks to the trade are a decline in risk sentiment, a retreat from the US Treasury's "strong dollar" policy by the new administration, and/or a failure of the US to meet already high expectations for significant fiscal easing.

EM sovereign credit has more downside

Our bullish dollar + bearish US rate view leaves us bearish on EM. In our view, Mexico, Brazil and Colombia (longer duration low spread foreign currency bonds) are especially vulnerable, while the higher yield and lower duration of lower quality and shorter EM bonds will be more defensive. A review of the taper tantrum (May 2013) shows that: 1) EM underperformed UST at the start; 2) BBB sovereigns underperformed the most, and had not yet recovered in a year; and 3) BB and B-rated bonds recovered to beat USTs 8-10 months later. This time, we expect a sharp selloff with an eventual recovery.

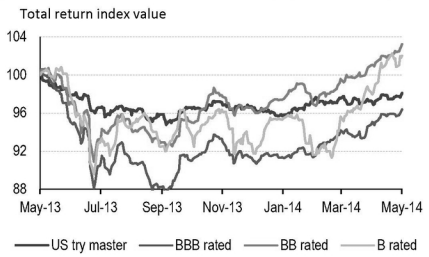
Our bearish view on LatAm credits in particular is driven by 1) positioning in LatAm is heavier than in EMEA or Asia – watch outflows from IG crossover investors who will rethink their EM IG investments; 2) their exposure to commodities and 3) vulnerability to a potential decline in US trade. Our choice of the basket is fairly obvious - Mexico is clearly the most vulnerable to NAFTA and a decline in remittances, uncertainty on the pace of the economic recovery and debt dynamics are extremely challenging in Brazil while tax reform delays could mean a credit rating downgrade in Columbia.

Taking account of both oil and US rates as independent variables, a regression analysis shows that a 100bp Tsy backup would be related to 30-45bp wider spread (Chart 22). Note that residuals show spreads are currently about 35bp too tight.

The trade: Sell equally weighted basket of Mex 47s, Brazil 45s and Colom 44s Current average yield: 5.74%, annual carry & roll 30bp; target: 6.35%; stop: 5.25%

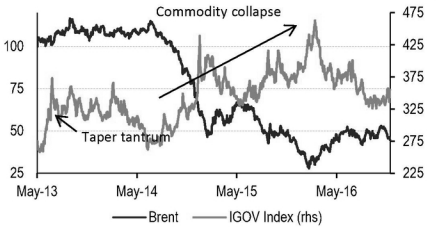
On a portfolio basis for benchmark real money investors, we recommend moving out of long higher quality LatAm, leaving higher yielding shorter bonds. A commodity price rebound or a reversal of US rates is a risk to the trade.

Chart 21: Total return of EM sovereigns during taper tantrum May 2013



Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 22: EM sovereign spreads widen with declining oil prices Jun 2014



Source: BofA Merrill Lynch Global Research, Bloomberg

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Leading Indicators

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Brace for faster global growth

- Our leading indicator of leading indicators (LILI), shows that global growth will likely continue to improve in early 2017.
- Faster global growth as anticipated by LILI supports higher rates and reflation.

A leading indicator of leading indicators

Investors use leading indicators to try to anticipate turning points in economic activity because those turning points drive FX, rates and stocks. One transmission channel is that turning points usually anticipate monetary policy changes. The most reliable leading indicators available summarize a battery of activity, financial and qualitative variables. One example is the set of Composite Leading Indicators (CLIs) calculated by the OECD, which is heavily used by policy makers and market participants.

The problem that we have with leading indicators is they are not really useful to market participants because they move *after* the market does. That is, leading indicators anticipate growth but not the market because they use financial variables to anticipate growth. Leading indicators rely heavily on interest rates, stock market indexes and exchange rates because they incorporate vast information quickly.

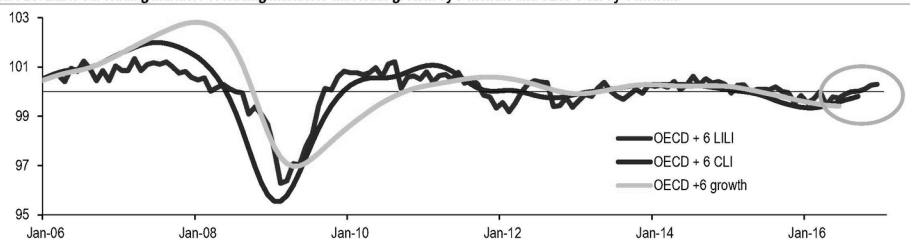
LILI solves the problem in two dimensions. It is not based on financial variables. Rather, LILI is based on qualitative data, consumer and business confidence, which we believe are optimal to capture "animal spirits." And, it is constructed explicitly to anticipate the CLI, as we use a dynamic forecasting regression with lags of consumer and business confidence to calculate LILI.

The signal for early 2017

LILI indicates that in early 2017 global growth will continue with an improving economic outlook (Chart 23). Consumers and firms seem to be bullish around the world, because LILI anticipates an even stronger outlook than the CLI. Here global growth means growth in the OECD plus the six largest non-OECD members. LILI anticipates the CLI by four months, and the CLI in turn anticipates growth by three months.

LILI supports our house view of higher rates and reflation, as the peak of the business cycle is not in the forecasting horizon. Since LILI is not based on market measures, we are confident that LILI anticipates market movements as well.

Chart 23: LILI is our leading indicator of leading indicators that leads growth by 7 months and OECD's CLI by 4 months



Source: BofA Merrill Lynch Global Research, OECD. Note: OECD + 6 includes the 33 OECD member countries plus the largest 6 non-OECD members: Brazil, China, India, Indonesia, Russia and South Africa

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The nuts and bolts of LILI

We used the OECD database of monthly economic indicators to look for non-financial variables that could anticipate the CLI. We use small and simple forecasting regressions, as they sometimes adjust more quickly to structural changes than large regressions or regressions based on large data sets. And, we already have a big-data leading indicator, published in our Year Ahead a year ago. We looked only at models with two independent variables (and their lags) and with variables of the same "type" (production variables, or employment variables, or confidence indicators). Further research can be done to use models that mix variables, although those models are more difficult to interpret.

We used two criteria to select between models. One was Granger-causality tests, which amount to joint tests that the lags of the independent variables are statistically different from zero in our dynamic regressions. The other was the Bayesian Information Criteria (BIC), a measure that looks at the fit of the regression (the r-squared) but that penalizes large models. We found that production measures and confidence indicators usually performed better in our training sample (1980 to 2014), although confidence measures usually had a larger lead. The model that used has a lead of four months and uses up to four lags of the standardized consumer confidence indicator (CCI) and of the standardized business confidence indicator (BCI) calculated by the OECD. Many models showed similar performance, which indicates that a combination strategy could be fruitful, although we did not take that route. No out-of-sample tests were performed.

We like LILI because it can anticipate the OECD's leading indicator without the use of financial variables. But we also like it because it is easy to interpret as it is based on confidence indicators and because those indicators are not subject to data revision, unlike variables such as GDP or payrolls.

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Inflation party starting but Eurozone not invited

- Eurozone breakevens have benefited from US move, but we see its sub-target problem becoming more entrenched. Sell OATei 2047 vs OAT 2066
- FX pass-through considerations and the prospect of firmer oil prices and leave us favoring breakevens in Thailand and Mexico.
- We expect inflation divergence in G10 economies. Our analysis of inflation and deflation risks support buying USD/JPY and selling CHF/SEK.

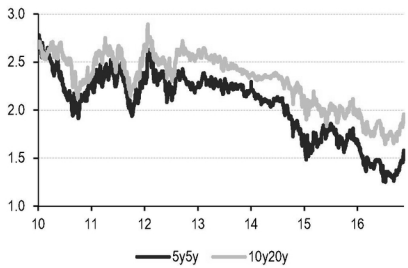
Rising Eurozone breakevens – the triumph of hope over experience?

The rally in Eurozone breakevens and inflation swaps looks mild compared with the recent US experience, for obvious reasons, but it has still been meaningful. The widely followed 5y5y has rallied from a 1.25% low to 1.58% and the 10y20y forward rate is at 1.96% (which qualifies as meeting the ECB's 'below but close to 2%', we'd say, albeit without the inflation risk premium we were used to in the past).

It is hard to argue with what looks like a beta-weighted response to the US move, perhaps. After all, there is a global component to inflation and if the US is driving that now, then Eurozone inflation expectations should firm, it can be argued. And if we are in for a Reaganomics-style fiscal stimulus, then it is quite possible that we will get the dollar strength associated with that experience; if so, the Eurozone might get to import a little inflation by being on the other side of that currency move.

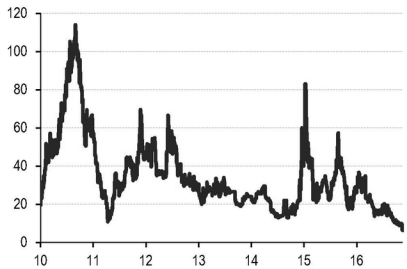
However, we are somewhat troubled by the fact that the inflation options market has priced out the risk of deflation almost completely (Chart 24). Has that threat really been extinguished? Yes, inflation expectations have risen but the rise in real yields has also tightened monetary conditions and there remains the threat that in December the ECB fails to commit to ongoing stimulus on a sufficient scale to satisfy markets that it can return inflation to target.

Chart 24: Euro inflation expectations rally; long term forward at target, %



Source: BofA Merrill Lynch Global Research

Chart 25: Perceived deflation risk goes; 5y ZC 0% inflation floor price, c



Source: BofA Merrill Lynch Global Research

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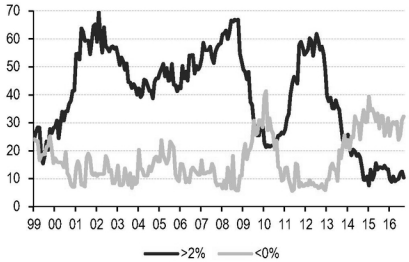
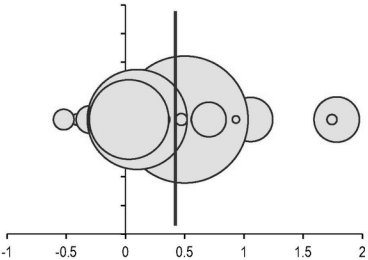
Chart 26: The Euro HICP – weighted index proportions recording inflation below 0% and above 2%



Source: Eurostat, BofA Merrill Lynch Global Research

Chart 27: Eurozone member country inflation rates, with bubble sizes proportionate to index weights



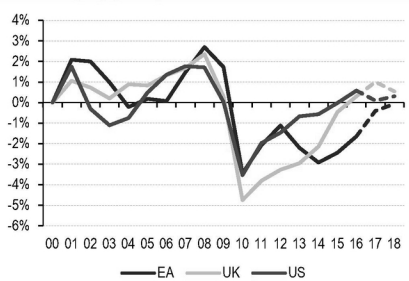
Source: Eurostat, BofA Merrill Lynch Global Research

Core inflation at 0.8% is barely above the 2015 low of 0.6%. One statistic that often grabs attention is the high proportion of HICP index components recording deflation (currently 31% on a weighted basis). However, much of this represents volatile non-core components so is less of a concern. The bigger problem is the fact that even after we take out all these components recording deflation, the 69% of the index remaining is only recording a weighted average inflation rate of 1.3%. Chart 26 shows that the more serious problem is that only 10% of components in the basket are recording inflation rates above the 2% target. So there is a "lowflation" clustering problem by index item and Chart 27 shows that there is also a lowflation clustering problem by country. In fact, the country clustering is even more concentrated than it looks if we allow for the fact that the bigger of the two upside outliers, Belgium (1.8% inflation), has experienced a presumably unrepeatable increase in the tax rate on electricity from 6% to 21%, as well as other excise duty increases.

One might be tempted to give the Eurozone the benefit of the doubt on inflation, insofar as its output gap remains material. However, the closure of the output gap still requires strong and continuing stimulus, we would argue, and even that does not guarantee that somehow inflation resets to target.

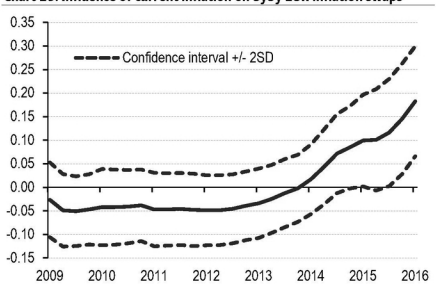
Our worry about item and country lowflation clustering is not that inflation is "unanchored". Our concern is that it flags a "re-anchoring" of inflation at a level well below 2% and that this new anchor will prove difficult to dislodge.

Chart 28: Output gap as % potential GDP



Source: BofA Merrill Lynch Global Research , AMECO

Chart 29: Influence of current inflation on 5y5y EUR inflation swaps



Note: The chart shows the slope of the regression of 5y5y on current inflation, with rolling windows of 29 quarters
Source: BofA Merrill Lynch Global Research, Bloomberg

Bank of America Merrill Lynch

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Economists place great store in the importance of expectations and their impact on inflation. Chart 29 suggests an adverse feedback problem has emerged, with actual inflation an increasingly influential driver of 5y5y inflation (and economist long-term consensus expectations).

With 10y20y inflation effectively at the ECB's target, we favor short positions in 30y breakevens. In the case of the OATei 2047, the "observed" breakeven drastically understates what we would consider to be a fairer measure. The issue here is that the linker is almost 10 years longer than its nominal 2045 comparator in modified duration terms. On a duration basis, the linker lies in between the 2060 and 2066 nominal OATs and, of course, the 30s50s OAT curve is very steep.

Trade: we recommended a more closely-matched breakeven trade, shorting OATei 2047s to buy OAT 2066s to give a breakeven of 163.3bp, targeting 130bp with a stop-loss at 180bp on October 14. The breakeven has risen, against our expectations, to 169.6bp currently and we regard this as an attractive entry level. We will nudge our stop-loss level higher to 185bp.

The relative cheapness of the nominal 50y partly reflects the 31y maturity limit to ECB buying. We regard the ECB eligibility premium for bonds within the ECB's buying range (like this linker) as material, so the trade should be a beneficiary in the event of an ECB "taper tantrum". An important additional feature in these turbulent times is the greater dispersion of the nominal's cash flows (in PV terms). This means the trade is significantly net long convexity.

We see the risks to the trade being a strong Eurozone recovery causing a general repricing of breakevens higher and the possibility of further heavy issuance of 50-year bonds across the Eurozone.

EM linkers: feeling the contagion for higher breakevens

The prospect for higher yields in the US clearly affects the appetite for Emerging Market (EM) assets including inflation-linked bonds. The discussion is about not only EM becoming less attractive on a relative basis, but also how the higher yields in the US affect the dollar and thus EM currencies.

Fiscal stimulus prospects in the US should continue to drive some correction across EM assets, but at this point, there is still too much uncertainty on the actual reach of such stimulus. Investors faced strong returns in EM this year and because of the calendar effect, this puts pressure to square positions and reduce risk. While this correction may last for a while, it is clearly creating more value in some assets. For now, the discussion will be about re-sizing positions rather than valuation. Only when volatility declines and yields stabilize in the US will we be able to resume discussion on valuation and the level of yields across EM.

Liquidity is a key issue when looking into EM linkers, in particular across EMEA, but we find some interesting opportunities in Asia and LatAm.. Currency weakness ends up adding risks for higher inflation in some countries but FX pass-through varies a lot depending on output gap. In general, we believe there is room for higher breakevens in EM, with key highlight for Thailand and 10y in Mexico.

Attractive breakevens in Thailand and Mexico

In Asia, we believe breakevens are pricing in too much complacency on the inflation outlook. With prospects for higher oil prices, it makes sense to position for higher breakevens in both Thailand and Korea in our view. Breakevens appear cheaper in Thailand as inflation is already increasing, while breakevens have clearly lagged the movement.

In EMEA, linkers are mostly illiquid and/or expensive so there is more to do in nominals and/or FX in our view. Yet, the currency move has triggered a widening in breakevens in some countries like South Africa. We expect this movement to continue for now.

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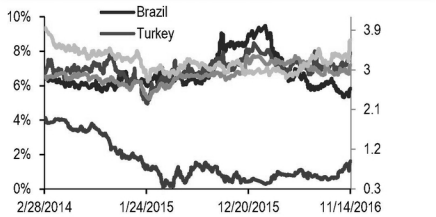
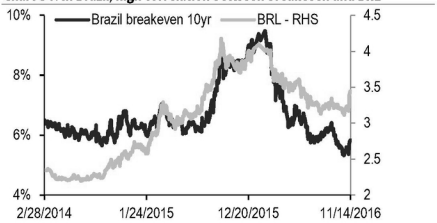
Chart 30: Breakevens to increase in some EM



Source: Bloomberg

Chart 31: In Brazil, high correlation between breakeven and BRL



Source: Bloomberg

Finally, in LatAm, we expect inflation to increase in Mexico, driving breakevens higher across the curve. Although FX pass-through is very low in the country, the ongoing MXN depreciation may add some pressure on inflation at the margin. In the case of Brazil, the central bank was very successful in anchoring long-term inflation expectations driving breakevens lower across the bond curve. For long-only investors, we believe linkers should be more resilient versus nominal bonds.

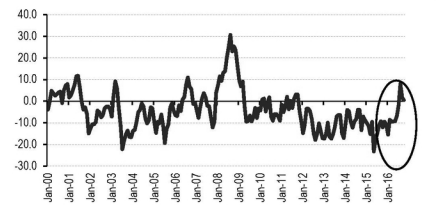
While Brazil continues to have one of the highest nominal and real yields across the globe, further compression requires stabilization in US yields. As long as the Brazilian government is able to deliver on the reform front, approving a social security reform bill next year, we see room for real yield compression from levels above 5.5% right now.

Buy USD/JPY, sell CHF/SEK

Inflation may not be back yet but deflation risk is most likely gone in most regions in our view (the notable exception being the Eurozone, we believe, as discussed above). A year ago we argued that the market deflation position was stretched and that there was room for inflation surprises. Indeed, average inflation surprises in G10 economies have been increasing since then and are now clearly in positive territory (Chart 32). Monetary policy in G10 economies is the loosest it has even been, suggesting that global inflation could continue rising (Chart 33). This is not necessarily bad news, as the threat of deflation is now gone. However, inflation rather than deflation trades are likely to become an important driver in G10 FX.

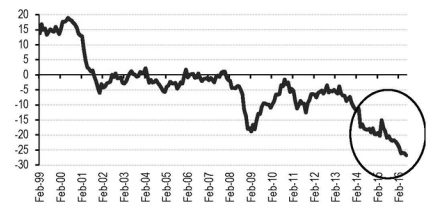
We update a heatmap of inflation risks in G10 economies to determine how to position for such risks in FX. We have discussed the methodology in Inflation and FX: What if the dog starts barking?. The idea is to rank currencies based on a number of early warning inflation indicators. Using equal weights, if most indicators point towards higher inflation for a currency, we take this to suggest that investors should go long, against a currency for which most indicators point towards deflation, both in relative terms.

Chart 32: G10 inflation surprises (average)



Source: BofA Merrill Lynch Global Research.

Chart 33: G10 sum of spreads from Taylor rule



Source: BofA Merrill Lynch Global Research.

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Table 1: Heatmap of inflation risks (green for high, red for low, in relative terms)

Source: BofA Merrill Lynch Global Research.

The results in Table 1 are supportive of the USD and the scandies against JPY, EUR and CHF. This is fully consistent with our projections for 2017, expecting USD strength to continue, particularly against JPY, and the scandies to do well against EUR and CHF.

Based on this analysis, we recommend buying USD/JPY and selling CHF/SEK, to position for inflation risks in G10 economies. Long USD/JPY is also our top directional trade for 2017 and we already have a trade recommendation to sell EUR/SEK. Therefore, we would recommend selling CHF/SEK as a new trade to position for inflation risks. CHF/SEK is one of the most overvalued crosses in G10. It is currently at its highest value ever, with the exception of the level reached when the SNB removed the EUR/CHF floor. We also expect the SNB to intervene to offset FX pressure, while higher uncertainty increases risks of a rate cut.

The risk to this view is if tail risk scenarios unfold in European politics, such as an early election in Italy with Five Star winning, or Le Pen wining the second round in the French elections. Although we expect markets to be more concerned about European politics following the US elections, we do not see tail risk scenarios in our baseline.

Trade: We recommend selling CHF/SEK, from spot at 9.184, with a target of 8.4 and stop loss at 9.5.

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Best Relative Value Trades

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Relative value in a macro world

- Long EUR/JPY: data and positioning supportive; the BoJ has more tools to address sustainability challenges than the ECB.
- Long RUB/KRW: US fiscal expansion suggests more upside for reflation sensitive Russia than interest rate sensitive Korea.
- Sell German 2y vs OIS, buy 10y vs OIS: fade the impressive richening of short-maturity German govies.

Long EUR/JPY

In a recent report we argued that EUR/JPY could appreciate in the months ahead as the BoJ gains credibility and the ECB has to deal with QE constraints. Since then, the EUR/JPY has appreciated by 3%, but we see more upside. Although we expect the ECB to extend QE by a further six months in December, we see more difficulties next year. Extending QE will require difficult decisions, such as relaxing the capital key or buying below the depo rate. QE tapering is therefore a risk and the market could start testing the ECB. Even if Draghi succeeds, the Euro could strengthen in the meantime. In contrast, the BoJ's new framework should address the sustainability challenges that Kuroda faced this year, and allows more fiscal stimulus by keeping the government's borrowing costs at zero. The ECB cannot do this, in our view. We have been short EUR/JPY this year, as we were expecting the ECB to extend QE, while the BoJ faced challenges.

Data also suggests further EUR/JPY upside. Relative GDP growth would be consistent with a stronger EUR/JPY, as the Eurozone has been gaining momentum, while growth in Japan remains weak (Chart 34). Relative central bank balance sheets give the same signal (Chart 35). Positioning is also in support, as our analysis suggests a short EUR/JPY market position (Chart 36).

If the external environment improves, we think Japanese investors are likely to be JPY sellers again as the hedge ratio and hedge costs have both risen. One of key factors of the yen's appreciation this year might have been that, as the USD/JPY fell, institutional investors implemented additional FX-hedging to their existing forex positions as part of their risk management, which caused the USD/JPY to fall further and supply-demand to worsen in a vicious circle. However, this mechanism probably ran its course when the USD/JPY reached 100 on the Brexit vote as we argued in $/¥'s eventual surge: Buy Nikkei 06 September 2016. In fact, the USD/JPY has stopped falling during Tokyo trading hours since the summer. Based on the decline of foreign yields and higher hedge costs, hedged US Treasuries and German bunds had lost nearly all of their attraction for Japanese investors by the summer. US and German 10yr government bond yields sank to about 0% after being hedged to the JPY, reflecting that downward pressure on yields had reached the limit. Institutional investors are expected to increase their exposure to unhedged foreign bonds in H2 FY16. Investor behavior is especially liable to change in April, when the new fiscal year starts.

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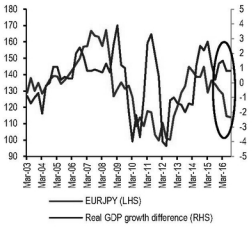
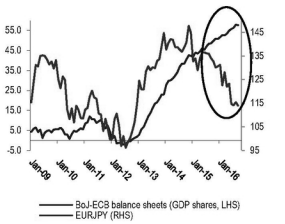
Chart 34: EUR/JPY and real GDP growth



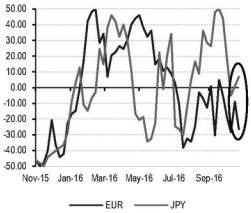
Source: BofA Merrill Lynch Global Research.

Chart 35: EURJPY and relative central bank balance sheets



Source: BofA Merrill Lynch Global Research.

Chart 36: EUR and JPY market positions relative to the last 12 months



Source: BofA Merrill Lynch Global Research.
For more details, see Liquid Cross Border Flows.

EUR rates are probably more vulnerable against US rates movements, as the market questions whether the next ECB move will be expansion or tapering. On the other hand, Japanese rates are insulated from foreign movements as the BoJ directly targets the 10yr yield. Japanese fiscal easing is also a possibility in light of reduced odds of TPP implementation and a potential snap election. Any positive impact of Japanese fiscal easing on growth is likely to manifest in higher inflation expectations under the BoJ's yield-targeting regime, which means Japanese real interest rates could actually fall.

Based on these considerations, **we recommend buying a 6M EUR/JPY 122/130 call spread for 1.2312% EUR (spot ref. 116.84).** Risks to our trade include a severe global shock that could strengthen the JPY, or the return of the Eurozone crisis; for example, if the government in Italy falls after Renzi loses the referendum in December or Le Pen wins the elections in France.

Long RUB/KRW

Post US elections and the improved outlook for fiscal expansion in the US, we see more upside in being long oil and reflation sensitive Russia than short technology and interest rate sensitive Korea.

We recommend being long RUB/KRW heading into 2017 targeting a move to 19.4 (spot ref 18, stop 16.7). The trade is positive carry 2% per quarter.

The rise in US breakeven inflation is positive for risky assets broadly but could be painful in the short term for highly indebted countries with low interest rates. Higher US breakeven inflation rates are historically associated with higher RUB/KRW (Chart 37).

Higher US real rates are also less of a threat for Russia where local real yields are significantly higher than Korea (Table 2) and most EM peers. Korea also has relatively high private sector debt which could face pressure if BoK is forced to raise rates. Household debt has been rising at an alarming rate and domestic political turmoil facing the Park administration has also added to concerns.

In our baseline scenarios, we expect a modest growth recovery for Korea but a stronger delta for Russia where the oil price collapse over 2014-15 led to a much sharper slowdown earlier and activity is now in recovery stage.

The ToT trade shock that hit Russia in 2014 led to material underperformance in exports vs Korea. Over 2011-13, Russia and Korean exports were growing at about the same rates but since 2014 that gap widened has materially against Russia. Since early 2016, however, this has reversed with Russia catching up. In 2017, Russian exports growth could outperform Korea given the outlook for oil. Moreover, it is less reliant on China or Japan and more reliant on Europe. CNH/KRW as well as JPY/KRW remains near multi year

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lows suggesting this will be a source of pressure on the Won given the greater trade linkages (Table 2).

Our current account forecasts for 2017 anticipate deterioration in Korea's current account surplus compared to marginal improvement in Russia's. Recent issues at Samsung and Hanjin pose risks for the goods and service balances, respectively. Electronics account for 30% of Korea's exports. While a stronger dollar and energy de-regulation in the US could dampen the oil market, our energy strategists continue to expect further modest gains in Brent over 2017. The RUB/KRW cross has a modest positive beta to oil at 25% since the beginning of 2014. Risks to the trade are mainly material downside to oil prices vs our baseline scenario.

Sell German 2y vs OIS, buy 10y vs OIS

In H2 2016, we saw an impressive richening of short-maturity German govies and repo: we like fading the move by selling 2y Bund vs OIS and buying the 10y vs OIS.

German 2y is pricing-in structurally high demand and low supply

The German 2y trades at the richest against OIS since the peak in 2011 due mainly to demand/supply dynamics driven by: 1) European regulation on mandatory central clearing and minimum initial margin requirements generating €350bn in extra collateral needs in 2016-19; 2) LCR regulation and negative rates having pushed cash-rich corporates into holding short-end German bonds/bills in order to store liquidity; and 3) net bill issuance having been cut to negative in Q4 because falling yields created €42bn of excess cash for governments.

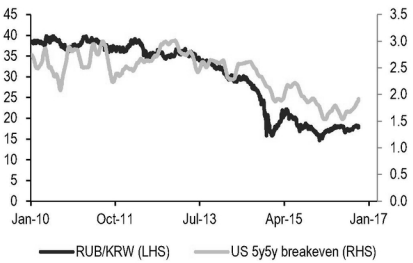
Supply pressures are expected to ease in 2017E

Bubill auctions will resume after more than two months of absence while more treasuries may be the answer to an excessive rise in yields by increasing net issuance in the front-end. The ECB may also be concerned by the richness of front-end German govies (see Couré's speech on 3 November). If the Eurozone fails to create enough safe/low-volatility securities for the market to work efficiently, then the central bank could compensate by lending more collateral, by adjusting counterparty frameworks and running higher balance sheets or even by issuing bills to satisfy safe asset demand in the non-bank system.

ECB QE and potential periphery stress supports 10y outperformance

Given the tail risks in 2017 and our call of ECB QE extension to September 2017, we prefer to add a 10y DBR long vs OIS – we expect 10s to outperform in such a scenario. In Chart 38 we show that ECB tapering expectations have now pushed 2s10s vs OIS to levels before the announcement of ECB QE on 22 January 2015. However, we see even more reasons for the ECB to extend the €80bn per month in QE to September 2017.

Chart 37: Return to a different time



Source: BofA Merrill Lynch Global Research, Bloomberg

Table 2: Russia vs S. Korea factors

	RUB	KRW
Real rate*	4.2	0.9
CA change forecast, '17 vs '16	1.2	-1
Growth delta forecast, '17 vs '16	1.6	0.2
NFA / GDP+	1	-5
Pvt credit (% GDP)	50	80
Foreign holdings of local debt (USD bn)	20	67
FX reserves / ST debt	6	3
Share of US in exports	2	13
Share of China in exports	10	25

* 1y fwd 5y yield vs inflation forecast
+Countries net external position vs BIS-reporting banks

Source: BofA Merrill Lynch Global Research, Bloomberg

Bank of America Merrill Lynch

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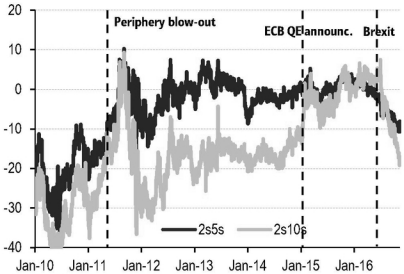
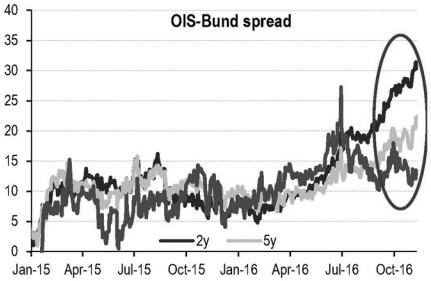
Chart 38: Low repo rates and ECB QE tapering push 10s to pre-QE levels



Source: BofA Merrill Lynch Global Research

Chart 39: 10y Germany is historically cheap on the OIS curve



Source: BofA Merrill Lynch Global Research

10s would be particularly supported if the ECB increases the holding limit of non-CaC bonds to 50% – a tweak we see as the most likely. Also, given the already stretched valuations in the 2y, we think a rise in geopolitical risks or a blow-out in peripheral spreads would increase collateral values of 5s and 10s more than the front-end – as happened during the first BTP spread widening in 2011 or the Brexit referendum.

We recommend investors go long the DBR Aug26 vs OIS and short the BKO Dec18 vs OIS at current levels of -17bp, targeting 14bp and with a stop at -34bp. The position has 1.1bp in 3m Carry and Roll. The main risk in the short term is ECB QE failure, while tighter short-maturity securities supply or lending is the main risk over the longer term.

HOUSE_OVERSIGHT_014751

Best Contrarian Trades

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What if populism is too popular?

- **G10:** Short inflation/long duration through US 3-year 0% US inflation floors as stimulus may falter. Short EUR/GBP as "sending the letter" may be the low point.
- **EM:** Short JPY/KRW, short BRL/MXN as US policies may hurt EM less than feared. Long Turkey Eurobonds as sentiment may improve by the referendum in spring.

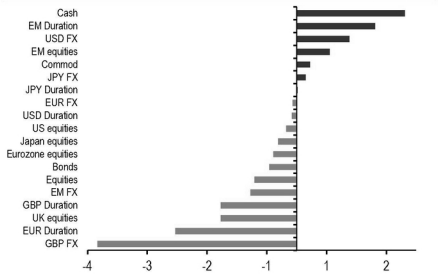
"Long populism" becoming consensus

While we received a lot of pushback for pointing out the risks ahead of the US elections, now "long populism" is quickly becoming consensus. The naysayers may argue that the establishment could reassert itself: conservatives may constrain fiscal stimulus and protectionism, and central bankers may stay dovish (remember the ECB too). We suggest five trade ideas: 1) short inflation/long duration; 2) short EUR/GBP; 3) short JPY/KRW; 4) short BRL/MXN; and 5) long Turkey sovereign where populism may calm.

Populism is getting popular

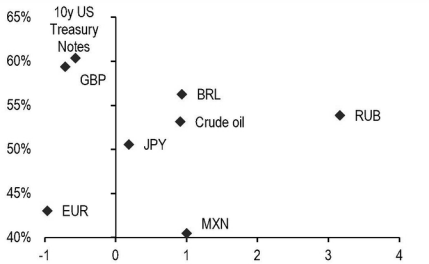
5y5y US inflation swaps have spiked 60bp since summer to about 2.5% – the biggest move since 2009. As a consequence, EM has sold off sharply. Our pre-election sentiment surveys partly explain the violence of the moves since 8 November: investors were long EM bonds and equities and neutral duration in the US (Chart 40). The latest CFTC data show a similar picture, with short GBP and long BRL, Crude, RUB and even MXN most extreme vs history; note also a short in US Treasuries. Purely statistically speaking, the shorts in GBP and US Treasuries are most vulnerable to a near-term reversal – though momentum may prevail for a while in Treasuries (Chart 41). When the dust settles, the contrarian may find opportunities in "short populism" trades.

Chart 40: Our pre-election surveys show investors bearish GBP, duration



Note: positioning score relative to history. Source: BofA Merrill Lynch Global Research

Chart 41: CFTC data show positioning is very short GBP



Note: x-axis: 1y z-score of net long spec positioning as of November 8; y-axis: probability of a price reversal in the week after. Source: BofA Merrill Lynch Global Research, Bloomberg, CFTC

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Rates: short inflation/long duration

Positioning surveys generally indicate that the rates market is neutral or short duration amid rising inflation expectations. According to our rates & FX sentiment survey, clients are relatively short in relation to their average positioning across major fixed income markets including the EU, UK, and to a lesser extent the US (Chart 42). Such position indications suggest that contrarian investors should be long duration in Europe, the UK, and the US. These positions have been factored into some of our pre-existing fundamental views, which include receiving euro vs US rates and expecting UK supply/demand dynamics to be supportive of longer-dated Gilts going into year end. We are reluctant to recommend outright long duration positions in US rates at present given that the sharp election-induced selloff could extend over the coming weeks.

Consensus expects rising inflation

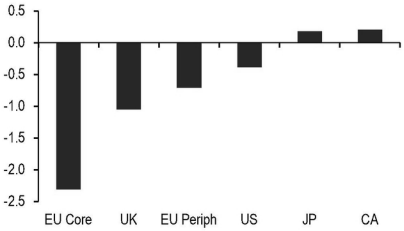
Instead, we focus on contrarian views regarding the outlook for inflation, which underpinned some of short rates positioning and is expected to increase with US fiscal policy expansion and base effects. According to our recent Global Fund Manager Survey taken prior to the election, global inflation expectations are on the rise, with 70% of survey respondents expecting higher global CPI readings in the near term. Headline CPI has been moving higher in the US, and Chinese PPI recently turned positive for the first time since 2012. Similarly, global market-based measures of inflation expectations have been rising, with 5y5y forward inflation swaps in the US, UK, and Europe all rising over recent months and US inflation protected funds receiving nearly $2 billion in inflows since the start of October.

Disinflation may strike back

Risks to the near-term outlook for inflation could rise if: (1) expectations for US fiscal stimulus disappoint as House deficit hawks insist on revenue-neutral tax cuts or spending measures; (2) Beijing pushes the RMB lower before President-elect Trump takes office leading to risk-off and imported disinflation; (3) commodity prices decline if an OPEC deal cannot be reached, the USD meaningfully appreciates, or if EM growth falters; or (4) EU slowdown fears rise should the ECB taper due to technical constraints.

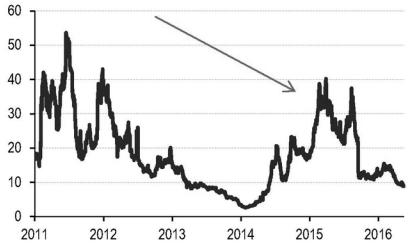
We recommend buying 3-year 0% inflation floors in the US, which currently demand only 9 basis of premium. These levels are low in relation to recent history and could increase if Beijing were to more rapidly weaken the RMB or if commodities falter (Chart 43). Investors seeking to offset the premium could consider selling longer-dated more deeply negative floors under the assumption that any near-term disinflation scare would be short-lived and likely be offset by more activist monetary policies thereafter. The risk to the trade is a spike in commodity prices or a continued rise in core inflation.

Chart 42: Z-score of duration positioning: short except in Japan/Canada



Note: negative z-score values indicate short positioning, positive z-score values indicate long positions; z-score taken from survey net exposure index with responses dating back to 1992 for US, CA, JP, UK & EU, EU periphery data available back to 2013. Source: BofA Merrill Lynch Global Research

Chart 43: Cost of 3Y 0% deflation floor has spiked with weak RMB (bps)



Source: BofA Merrill Lynch Global Research, Bloomberg

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FX: Sell EUR/GBP

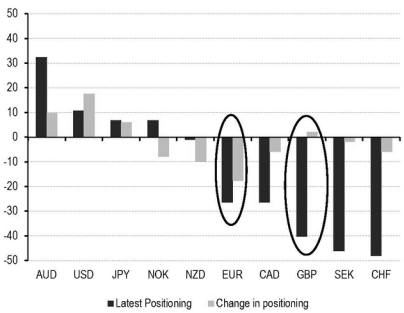
GBP remains a consensus short. Despite GBP appreciating following the High Court decision for a Parliamentary vote to activate Article 50 and the US elections, the market's short GBP position remains stretched according to our positioning analysis (Chart 44). Our Global Fund Manager Survey flags short GBP as the strongest consensus view in G10 FX. Our FX & Rates Sentiment survey also suggests that the majority of investors look for some type of hard Brexit. Although we have been arguing for upside GBP risks after the recent flash crash, our baseline projections expect GBP/USD to hit a new low of 1.15 in Q1 after the UK activates Article 50.

However, we have argued that GBP tail risks are skewed to the upside. UK data have been strong post-referendum and could continue surprising to the upside. There is room for positive headlines at the political front, if the UK agrees on the transitional period that could extend the current regime until a final trader deal with the EU. A Parliamentary vote on Article 50 activation could reduce the chances of a hard Brexit. And Trump's victory could lead to an early bilateral US-UK trade deal, while it increases the geopolitical importance of the UK for the rest of the EU. Moreover, we expect markets to become more concerned about political tail risks in the rest of Europe following Trump's victory in the US elections. Political risks in Italy and France could question the sustainability of the Eurozone, thus weakening EUR/GBP.

If Prime Minister Matteo Renzi loses the referendum on the constitutional reform in December, Italy could have a snap election, which the Five Star party could win based on the latest polls. Even if Italy avoids elections in 2017, the next election will take place by May 2018, and markets could become concerned about it earlier if Renzi loses the referendum. The 2017 French election is another concern. President of the far-right party and presidential candidate Marine Le Pen is ahead in the polls to win the first round. Winning the second round is much more difficult, as she will need more than 50% of the votes, but investors could start to expect the unexpected after being blindsided in the UK and the US. Other considerations also support selling EUR/GBP. Data are consistent with a weaker EUR/GBP (Chart 44). The market is short both EUR and GBP, but long EUR/GBP, with the latest flows pointing to more EUR downside and GBP upside.

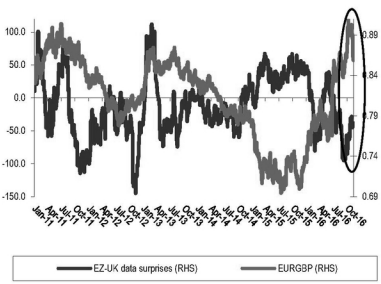
Using a spot reference of 0.8672, **we recommend selling EUR/GBP via a 6M 0.84/0.80 put spread, to capture both the referendum in Italy and the French elections, but also give time for GBP to recover in case it weakens further following activation of Article 50 in Q1. The structure costs 1.07% EUR**.

Chart 44: Positioning is short EUR but even more so in GBP



Source: BofA Merrill Lynch Global Research.

Chart 45: Data surprises suggest that EUR/GBP should be lower



Source: BofA Merrill Lynch Global Research.

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Asia: short JPY/KRW

Positioning surveys generally indicate that the most consensus Asia FX trades at current juncture are short KRW and SGD against USD through and short SGD against the NEER basket and short CNH against a narrow version of CFETS basket. Not surprisingly, these two basket trades also form a part of our trade recommendations. In fact, these shorts might have increased after US election outcome due to fears of protectionism.

As a result, we believe that contrarian investors should be long KRW, CNY and SGD against USD or JPY. Amongst these, our favourite contrarian trade is long KRW vs JPY.

Three triggers

Three reasons why the current developments may ironically be positive for Korean Won:

- After a brief period of outflows from the equity markets, we believe inflows are set to resume. A sustained rally in S&P Index due to the anticipated de-regulation and fiscal push will undoubtedly be positive for KOSPI (given the high positive correlation) and as a result for KRW. Moreover, history suggests that the current sell off in rates and KRW is unlikely to spur considerable outflows from the debt market.

- It is still not very clear if the outcome of this US election is going to be negative for foreign trade. Should these concerns decrease, positive impact from looser US fiscal policy could push Asia growth higher.

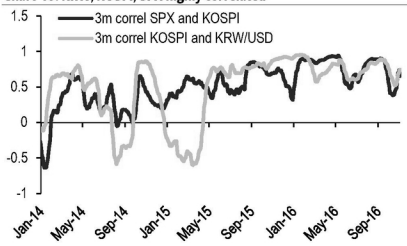
- The recent sell off in KRW vs USD from 1100 to 1150 is indicative that domestic concerns around politics, Hanjin shipping troubles and Samsung related issues seems to have been largely priced in. As a result, we believe that any additional domestic negative news is unlikely to adversely impact KRW materially.

Additionally, in terms of valuation, our long term COMPASS model indicates that the Korean Won is one of the most undervalued currencies in Asia.

JPY better than USD as funder

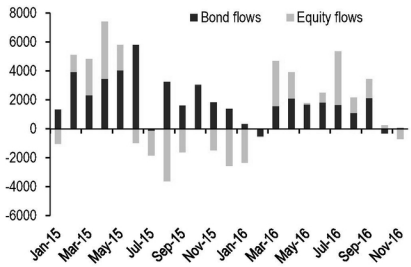
We believe it makes sense to express this contrarian view by short JPY instead of USD. Currently JPY/KRW is at 10.9 and our forecasts indicate it to be at 10.6 by Q4 2017. In the case of a stronger USD, we expect BOK to sound cautious with the pace of KRW depreciation and smooth the move higher in USD/KRW. Moreover, USD/JPY has greater sensitivity to USD rates than KRW.

Chart 46: KRW, KOSPI, SPX highly correlated



Source: BofA Merrill Lynch Global Research

Chart 47: KRW more influenced by equity flows than bond flows



Source: BofA Merrill Lynch Global Research

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LatAm: short BRL/MXN

Our top contrarian trade in Latin American markets is selling BRL/MXN (spot 6.00, target 5.00, stop 6.75). The trade benefits from valuation, positioning and our views of the expected effects of the US election on the Brazilian and Mexican economies.

MXN 10% undervalued, BRL 5% overvalued

We estimate the Mexican peso is about 10% undervalued while the Brazilian real is about 5% overvalued, based on our Compass valuation model. The model provides estimates of long-run equilibrium trade-weighted exchange rates consistent with the convergence of current account balances toward levels that are in line with country fundamentals that determine savings and investments.

Mexico's real exchange rate index is at its lowest since at least 1999, and about 35% cheaper than its long-run average. Brazil's real exchange rate has risen sharply in 2016 and is now around 8% stronger than its long-run average (Chart 48).

LatAm under Trump's world

We believe the election of Donald Trump as the next president of the US will be negative to Latin American economies. His economic plan will likely involve a significant fiscal expansion, perhaps tighter monetary policy and some protectionist's measures. These will likely lead to higher US rates and a strengthening of the US dollar. Higher international interest rates are a negative shock for emerging economies and any acceleration in US economic growth will be skewed to domestic nontraded goods.

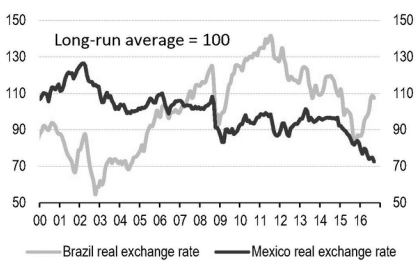
We think Brazil's economy will likely be more negatively affected since its strategy to gradually reduce budget deficits is based on low global rates, capital inflows and higher domestic growth.

Mexico, on the other hand, may benefit on relative terms from a construction and infrastructure boom in the US. Any revival in US manufacturing would also be good for Mexico, particularly if Trump's protectionist measures are not as substantial as feared.

Market is not positioned for a MXN rally and BRL selloff

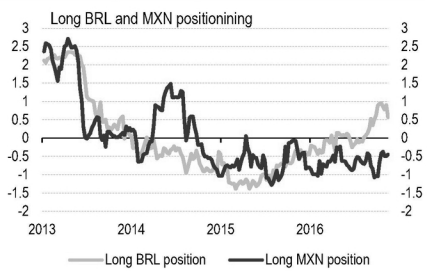
Selling BRL/MXN is a contrarian trade. Foreign investors are significantly long BRL according to our positioning index based on BM&F data. Market positioning by local investors is even more stretched toward long BRL. On the contrary, speculative investors are short MXN according our positioning index based on CFTC data (Chart 49). So positioning unwinding would actually help our short BRL/MXN strategy.

Chart 48: Real exchange rate is cheap in Mexico, expensive in Brazil



Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 49: Market is positioned long BRL and short MXN



Source: BofA Merrill Lynch Global Research, Bloomberg

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EEMEA: long Turkey credit

Turkey has been one of the big underperformers among the major EM lately, and now valuations are the most attractive in a long time. Sovereign credit spreads are down to BB- levels even though the country is still rated as a BB+ credit (Chart 50). The lira which our Compass model has shown as overvalued for many years is now finally in line with the equilibrium of about 3.30 vs USD. The REER is almost down to the lows reached during the 2013 taper tantrum and 2015 China devaluation. In equities the discount vs GEM is at historical highs (Chart 51). So contrarians should get interested.

To be clear, we have been warning for a long time that the leverage and stimulus driven growth model was weakening and needed a boost through supply side reforms. And obviously political events have been manifold. But as we are talking about year-ahead trades rather than the near-term ideas, we believe it is worth noting that Turkish markets have a habit of alternating between bad and good years: 2010, '12, '14 good; 2011, '13 and '15 bad. After another bad year in 2016, one could consider a possible rebound in 2017.

Not a short-term trade

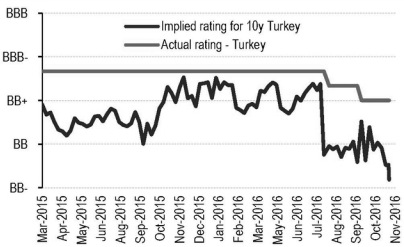
This is not a 1-month but rather a 3-6 months trade, where Q1 will likely be critical. In the short term, US rates volatility is harmful for countries like Turkey that have funded large current account deficits with short-term debt. This interacts with the local sentiment weakness that has lately resulted in rising deposit dollarization. An acceleration of this trend would now be the biggest risk to asset prices, in our view.

Before entering the trade we should see dollarization stabilize. Lately households have been net buyers of dollars for the first time since the coup attempt. We should see a couple of weeks of dollar selling to confirm that this potential risk is dissipating.

The trigger for a rebound from low valuations likely lies in a stabilization of sentiment which could occur during the first half of next year. Currently the state of emergency is scheduled to end in January, and the news flow suggests a referendum by April/May. In a positive scenario, politics calm down by the referendum which may also reduce the need for further stimulus through fiscal, monetary policy or moral suasion of the banks.

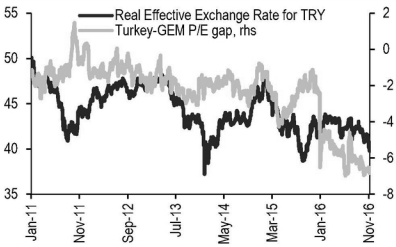
Among asset classes, we think Eurobonds provide the best risk/reward as the rating is a natural valuation "magnet", and the credit remains a solid BB+ fundamentally, in our view. Our preferred bonds would be the 26s (current: 5% for October 26s) on the 10y tenor and 45s (current 6.5%) on the long end. However, a rebound would also favor equities and local spreads. FX is least compelling as TRY has been asymmetric in recent years: big sell-offs and small recoveries. We think the reason is high inflation and a policy bias for a weaker exchange rate. In FX a positive view would be best expressed by selling the USD/TRY risk-reversal which is currently at around 5.0 and could target 4.0 in a scenario where the sovereign rallies back to BB+.

Chart 50: Turkey sovereign priced too cheaply at implied BB- rating



Source: BofA Merrill Lynch Global Research, Bloomberg,

Chart 51: Real effective TRY and Turkey equities near the 5-year lows



Source: BofA Merrill Lynch Global Research, Bloomberg, Haver, EPFR

HOUSE_OVERSIGHT_014757

Best Vol Trades

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Tension in Trump's policies are bullish for vol

- Weighing up the impact of fiscal easing vs protectionism and shifting from deflation to inflation risks should be bullish for vol.
- In rates, we see room for the belly of the curve to reprice to the dots. 2y1y should cheapen 75bp, vol is cheap vs rates and the skew the least expensive in that sector.
- In FX, we think vol and skew have room to reprice higher compared to the repricing seen in rates. We like cheapening a EURUSD put with a 3m30y strangle.
- In EM, USDCNH calls are attractive in our view. A stronger USD adds pressure to depreciate, while the risks of trade tariffs, labelling China a currency manipulator, etc could lead to a sharp re-pricing or risk premia higher.

Highest conviction in FX, belly of the US curve and CNH

We view Donald Trump's election as bullish for USD, bearish for real rates and challenging for EM. The inherent tensions in President-elect Trump's policy proposals, as well as the question marks over the Fed's reaction function should also support a repricing of vol higher, especially since neither FX, nor front-end rates volatility look stretched by historical standards.

However, expressing a view on long-end nominal rates is harder, and implications for rates vol are less clear. USD 5y5y breakevens are consistent with the Fed's definition of price stability for the first time in more than a year. In Europe, the sell-off in rates (both Bunds and BTPS) is tightening monetary conditions at a time when the ECB should do more, not less. Finally, the BoJ's yield curve control should provide an anchor for JGBs.

Consequently we focus on the following three trades:

11. Buying US$100mn 2y1y payer, struck at 2.50% (ATM+69bp)
12. Buying a EURUSD 3m 1.05 put, partly financed with a 150bp-wide 3m30y strangle
13. We recommend buying a 6m USDCNH 7.60 call

US rates to converge to the dots: attractive in vol

The view on long-end rates is complicated by the significant repricing of breakevens, the likelihood of the ECB doing more, and the BoJ defending its JGB yield target. We do, however, see room for a further increase in risk premia in the belly of the US curve. We believe that the market will ultimately view the Fed dots as a floor, rather than a cap. Supply pressures will weigh on the belly of the curve, rather than the long-end. This makes the cheapness of the upper left corner of the vol surface attractive.

As we look for a repricing of Fed expectations, to levels more consistent with the dot plot, **we recommend buying US$100mn 2y1y payer, struck at 2.50% (25-delta), i.e., ATM +69bp. The cost is US$165K, equivalent to 17bp of yield. We target a PNL of US$300K**.

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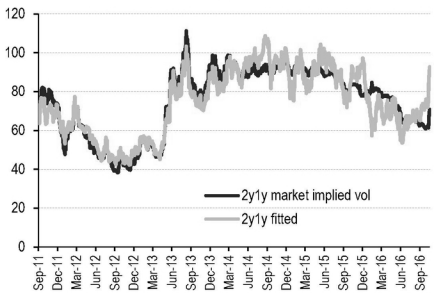
We estimate that it is in 3y1y, 2y2y and 2y1y that the selloff would be largest (75-85bp – see Table 5) were the OIS curve to align with the median dots up to end of 2019.

Options are attractive to position for a selloff in those forwards for two main reasons:

1. Volatilities in 1y and 2y tails appear to trade cheap on our macro model. More specifically, accounting for the relationship between implied vols and the first three principal components of the swap curve, we find that 2y1y implied vol should be trading 22bp normal higher (Chart 52), and 2y2y vol should be 19bp higher. A simpler historical regression of 2y1y vol vs the 2y1y forward rate also suggests normal vol should be around 21bp higher (Chart 53).

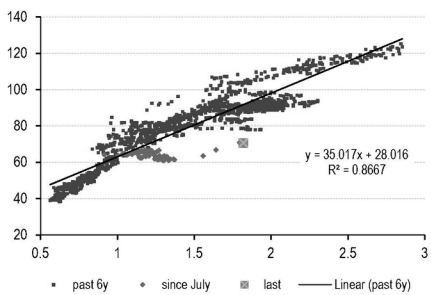
2. Payer skews could richen in 2y1y and 2y2y. While they are looking rich across 6M+ expiries in 1y and 2y tails (based on payer-ladder breakevens/ATM vol), we note that this has been the case for some time now and it's rather in gamma on 5y+ tails that skews now appear richest on a 6m z-score basis. Relative to what has been realized in the past month, the payer skew appears just fair in 2y1y, while it is rich across tails in longer expiries.

Chart 52: Market vs fitted level of 2y1y vol, based on macro model (*)



Source: BofA Merrill Lynch Global Research. (*) Based on a regression of log(2y1y vol) on the first three principal components of log of rates (derived with a PCA ran since Sep11). Rsquare = 0.91

Chart 53: 2y1y implied vol is 21bp too low on a regression vs 2y1y fwd



Source: BofA Merrill Lynch Global Research

Another way to look at this trade is through an analysis of payout ratios for 25-delta OTM payers under the scenario of a convergence towards median dots. Table 3 below confirms that the 2y1y point is attractive relative to other forwards (2nd best), with a net payout ratio of 1.9 (2.9:1 gross) after three months. The best payer on that metric is the 3m5y 25-delta OTM payer (strike of 2.05%), which we recommend as an alternative for those confident that the repricing of the OIS curve to the dots will take place by Feb-17.

Table 3: Payoff ratios when buying a 25-delta OTM payer, under the selloff scenario where forwards converge to the levels implied by the median Fed dots(*)

Trade	3m1y	3m2y	3m5y	3m10y	6m1y	6m2y	6m5y	6m10y	1y1y	1y2y	1y5y	1y10y	2y1y	2y2y	2y5y	2y10y	3y1y	3y2y	3y5y	3y10y
Strike (25-delta), %	1.31	1.54	2.05	2.44	1.49	1.73	2.23	2.60	1.84	2.08	2.51	2.84	2.50	2.65	2.95	3.21	2.98	3.08	3.28	3.47
ATM forward, %	1.14	1.34	1.77	2.13	1.24	1.43	1.83	2.17	1.44	1.62	1.96	2.25	1.81	1.92	2.17	2.38	2.04	2.12	2.32	2.47
Premium, bp of yield	4.1	4.9	6.9	7.4	6.5	7.5	9.6	10.0	10.4	11.5	13.4	14.1	17.0	18.5	19.2	19.6	23.8	24.2	23.8	23.8
3m roll, bp of yield	-4.1	-4.9	-6.9	-7.4	-5.1	-5.4	-5.9	-5.4	-5.0	-5.0	-4.3	-4.2	-4.4	-4.3	-3.3	-2.8	-3.5	-3.2	-2.6	-2.2
3m selloff to the dots	11	31	59	48	18	30	54	45	35	58	65	45	75	80	65	45	85	74	57	45
Return, bp of yield	-4.1	-4.4	16.5	5.4	-0.6	3.8	16.0	10.7	9.3	21.3	24.8	13.2	32.6	35.1	26.4	16.3	39.6	33.5	24.2	18.3
Net payout ratio	**-1.00**	**-0.89**	**2.41**	**0.73**	**-0.10**	**0.51**	**1.66**	**1.08**	**0.90**	**1.85**	**1.85**	**0.94**	**1.91**	**1.90**	**1.37**	**0.83**	**1.66**	**1.39**	**1.01**	**0.77**

Source: BofA Merrill Lynch Global Research. Data as of 15-Nov. (*) 3m selloff to the dots = the selloff in the different forward OIS if the OIS curve aligns with median dots up to Dec-19, with a flat rate of 2.5% thereafter.

The risk to the 2y1y and 3m5y trades is a rally and/or decline in implied volatility, i.e., the reversal of the selloff recorded since the elections.

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Own FX vs rates vol: cheapen USD call with rates strangle

We like **owning USD calls against selling US rates vol. In particular, we recommend buying a EURUSD 3m 1.05 put for US$100 pips (off 1.0730 spot), partially financed with the sale of US$100mn 150bp-wide 3m30y strangle (sold at US$600k**).

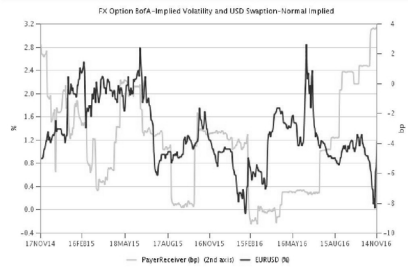
While potential fiscal stimulus has already been priced into rates term premia and rates volatility to some extent, it is not sufficiently priced into the FX market, in our view:

- Rates skew in gamma on long-tails has moved decisively for payers, while EURUSD skew is just beginning to price in higher US rates (Chart 59). This suggests to us that the market may already be partially protected against higher rates in the long-end, such that a further selloff may not see as strong a rally in gamma on long-tails.
- On the other hand, a further rally in the USD may catch investors under positioned and result in greater volatility in the currency markets.
- A principal component analysis of rates (US, EUR and JPY) and FX vols highlight that US rates vols and USDJPY vol are expensive, while 3m10y vol in EUR and JPY are cheap, along with EURUSD vol (Chart 60). While the cheapness of 3m10y vol in EUR and JPY can be explained by expectations of QE expansion in the two regions, we think that there is value in owning EURUSD vol.

From a terminal rates perspective, we are comfortable selling a 150bp-wide strangle for the following reasons:

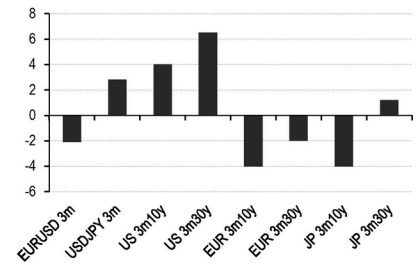
- We believe the result of the elections are a game-changer for the outlook on the US economy. As such we have probably entered a new regime for US rates whereby we are unlikely to retest the historical lows in 30y rates recorded in Aug-16 (1.67%). This suggests little downside in selling an ATM-75bp receiver (1.66% strike).
- In a scenario where US rates sell-off, USD is also likely to strengthen. The positive correlation between US yields and the USD has returned due to expectations for fiscal stimulus boosting economic growth. Furthermore, we would also argue that a substantial selloff in US rates, accompanied with USD strength may be self-defeating as it would put pressure on emerging markets and risky assets, thereby resulting in a flight to quality bid for USTs. The risk is that of large foreign reserve selling by EM central banks, putting upward pressure on US rates and downward pressure on the USD.

Chart 54: FX vol just beginning to price impact of higher rates



Source: BofA Merrill Lynch Global Research (*) payerReceiver = 3m30y 50bp OTM payer vol-50bp OTM receiver vol. EURUSD = 6m 25% OTM EURUSD put vol- 25% OTM call vol.

Chart 55: Residual of FX and rates volatilities based on a 1y PCA (*)



Source: BofA Merrill Lynch Global Research(*) Residuals derived from the first 2 principal components of FX and rates volatilities – based on a 1y Principal Component Analysis.

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From a mark-to-market perspective, the risk to the trade is a further rise in 3m30y US rates vol, coming this time with a depreciation in the USD (risk-off event in the US).

Potential US-China trade barriers: bullish CNH vol

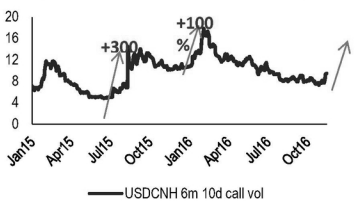
The Republican clean sweep has already sparked a strong USD rally and US rates selloff, but could put further pressure on the USDCNY exchange rate. A stronger USD by itself adds pressure to depreciate as China still needs looser financial conditions to maintain stability in the debt market, a relationship confirmed by the USDCNY rally following the 2015 Fed hike. With Trump's victory, we see increased risk of a larger depreciation.

Trump publicly labeled China as a currency manipulator on multiple occasions during the campaign, so any speculation of anti-trade policies could put significant depreciation pressure on the Renminbi. Potential trade tariffs on Chinese exports to the US could raise the probability of a trade war. Furthermore, Trump could encourage the Treasury to alter its criteria for labelling currency manipulators, which could also hurt trade relationships. Either scenario would lead to a sharp re-pricing of risk premia higher.

The Trade: Buy USDCNH 6m 7.60 call

We recommend buying a 6m USDCNH 7.60 call for 0.37% USD (off 6.9700 forward), with a target of 1% USD. USDCNH topside is now at the cheapest levels since the August 2015 depreciation (Chart 56). The trade could benefit from either a rally in spot as well as any increase in the risk premium between now and inauguration on speculation of anti-trade policies. The structure appreciates significantly from increases in volatility, which is plausible given the 300% increase in volatility in August 2015 and the 100% increase from October 2015 to February 2016. The risk to the trade is that China increases capital controls and dampens USDCNH appreciation, which could cause the options to expire worthless.

Chart 56: USDCNH topside the cheapest since pre-depreciation



Source: BofA Merrill Lynch Global Research

Table 4: Hypothetical trade performance on Inauguration Day (Jan 20th)

Spot	Vols unchanged	Vols 20% higher	Vols 50% higher	Vols 100% higher
6.8	-81%	-49%	24%	197%
6.9	-68%	-30%	41%	235%
7	-51%	-5%	100%	278%
7.1	-32%	49%	132%	305%
7.2	0%	103%	170%	378%
7.3	49%	122%	232%	441%
7.4	124%	200%	305%	522%
7.5	224%	319%	441%	630%
7.6	386%	470%	565%	741%

Source: BofA Merrill Lynch Global Research

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Stress testing CNY

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Stress testing CNY

- We stress test China's FX reserves to capital outflows and warn of a potential USD520bn fall in FX reserves in 2017, translating into higher CNY volatility.
- We also look at broader EM FX sensitivity to CNY depreciation and find ZAR and RUB most vulnerable.
- We examine if bond index and MSCI inclusion could significantly offset outflows, but are doubtful for now.

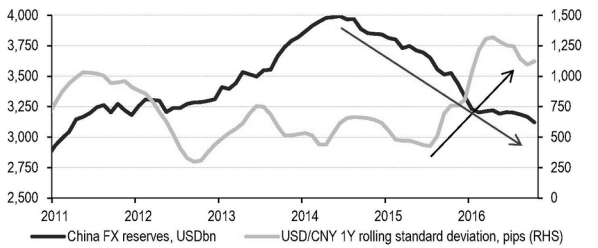
CNY – anything left in reserve?

We forecast USD/CNY to rise to 7.25 by year-end 2017 based on sustained capital outflows from China and the People's Bank of China (PBoC) allowing the exchange rate to depreciate accordingly. A key change in the PBoC's new FX regime, announced in August 2015, is to raise the influence of market forces over the exchange rate.

We showed that not all outflows are created equal. Some outflows are good and reflect structural changes in China's economy and liberalization of China's financial account; some outflows are ugly in the sense they represent illicit outflows. Yet both types of outflows are influenced by policy uncertainty in China, which we showed can explain a significant amount of capital outflows through Chinese purchases of overseas assets.

The impact of capital outflows alone on China's FX reserves is negative. A decline in FX reserves is also associated with an increase in volatility of the RMB (Chart 57). But the negative impact on FX reserves may be offset by China's trade balance. If China's trade balance and capital outflows are similar to that recorded in 2015 and 2016, then China's FX reserves would be between USD 2,600bn and USD 2,900bn in 2017. This represents a fall of USD520-220bn given current FX reserves of USD3,120bn and would amount to China having diminished control over its currency and higher CNY volatility – assuming no dramatic changes to capital controls.

Chart 57: China FX reserves (down) and RMB volatility (up)



Source: BofA Merrill Lynch Global Research, Bloomberg

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Table 5: Scenario analysis of China's 2017 FX reserves (yellow denotes lower reserves/ blue higher)

Capital outflow, USDbn	Trade balance, USDbn								
	100	150	200	250	300	350	400	450	500
300	2,885	2,935	2,985	3,035	3,085	3,135	3,185	3,235	3,285
350	2,835	2,885	2,935	2,985	3,035	3,085	3,135	3,185	3,235
400	2,785	2,835	2,885	2,935	2,985	3,035	3,085	3,135	3,185
450	2,735	2,785	2,835	2,885	2,935	2,985	3,035	3,085	3,135
500	2,685	2,735	2,785	2,835	2,885	2,935	2,985	3,035	3,085
550	2,635	2,685	2,735	2,785	2,835	2,885	2,935	2,985	3,035
600	2,585	2,635	2,685	2,735	2,785	2,835	2,885	2,935	2,985
650	2,535	2,585	2,635	[illegible]	2,735	2,785	2,835	2,885	2,935
700	2,485	2,535	2,585	2,63[illegible]	[illegible]	[illegible]	[illegible]	2,835	2,885
750	2,435	2,485	2,535	2,58[illegible]	[illegible]	[illegible]	2,7[illegible]	[illegible]	[illegible]835
800	2,385	2,435	2,485	2,535	2,585	2,635	2,68[illegible]	[illegible]	[illegible]785
850	2,335	2,385	2,435	2,485	2,535	2,585	2,635	2,685	2,735
900	2,285	2,335	2,385	2,435	2,485	2,535	2,585	2,635	2,685

2016 rate

2015 rate

Source: BofA Merrill Lynch Global Research, Bloomberg. 2016 rate is annualized from the first 3 quarters of data.

Table 5, above, shows a scenario analysis of China's FX reserves in 2017 under different trade balance and capital outflows. The analysis makes two assumptions. The first assumption is all the changes in the Balance of Payment's (BoP) reserve assets are reflected in the headline FX reserves figure. The second assumption is that the income balance is USD -36bn, which was derived from the annual rate since 2015.

We believe a decline of FX reserves to USD 2,600bn to USD 2,900bn would only be a problem for China if it attempted to implement a "fixed exchange rate" without capital controls. Such an FX regime requires heavy FX intervention and would put downward pressure on its FX reserves, making this FX regime choice no longer tenable for China.

The IMF's framework for calculating adequate FX reserves is based on whether there are capital controls and whether the currency operates on a fixed or floating exchange rate regime (Table 6). The latest readings show a fixed exchange rate regime without capital controls in China would require USD 2,911bn of FX reserves, which probably won't be achieved, as shown in Table 1. Meanwhile, a floating exchange rate regime with no capital controls would require USD 1,618bn of FX reserves. Fewer FX reserves would be needed to manage a floating currency that would adjust freely to capital flows. This reinforces the view that the CNY is moving toward a more flexible FX regime as its FX reserves are depleted (barring a draconian step capital control measures).

Skeptics may counter that China could always ratchet up capital controls to reassert control over its currency. However, the efficacy of this is questionable. The experience of 2016 shows that in spite of more capital controls introduced in late 2015 (e.g., onshore window guidance restricting the sale of FX by onshore banks) capital outflows have continued along with FX reserve depletion, albeit at a slower pace. Ultimately, this means China's ability to exert control over the CNY is being eroded, while the risk of more CNY volatility is rising. This is our scenario for 2017, with the tail risk that "ugly flows" or illicit capital flight due to domestic financial stability concerns could drive sharper CNY depreciation and FX reserve depletion. It is under this tail risk scenario that the temptation for draconian capital controls becomes a danger. For this reason, we believe it will be important to monitor the nature of the capital outflow and not just the size of the outflow. Good outflow such as Overseas Direct Investment by state-owned

Table 6: China reserves adequacy recommendations based on IMF guidelines

	Latest, USDbn	Capital control				No capital control			
		Fixed		Floating		Fixed		Floating	
		Weight, %	USDbn	Weight, %	USDbn	Weight, %	USDbn	Weight, %	USDbn
Short-term debt	767	30	230	30	230	30	230	30	230
Other liabilities	961	20	192	20	192	20	192	15	144
Exports	2,156	10	216	10	216	10	216	5	108
Broad money	22,728	5	1,136	2.5	568	10	2,273	5	1,136
Recommended reserves			**1,774**		**1,206**		**2,911**		**1,618**

Source: BofA Merrill Lynch Global Research, Bloomberg, SAFE

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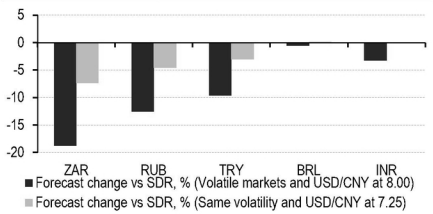
firms can be naturally slowed by internal directives. Bad outflow such falling CNY deposits among foreign subsidiaries of China banks can also be managed. However, it is the inherent speculative and unstable nature of domestic capital flight that we characterize as ugly flows that poses the greatest risk to the central bank.

Regressions and scenario implications for EM FX

We used a simple regression to quantify the impact of the RMB depreciation on key EM FX: BRL, RUB, INR, TRY, and ZAR[1]. We analyzed two cases: 1) Base case – USD/CNY rises to 7.25 and market volatility, which we use the VIX as a proxy, is unchanged from its current level; 2) Risk case – USD/CNY rises to 8.00 and intense RMB depreciation expectations cause market volatility to rise by three standard deviations. We find:

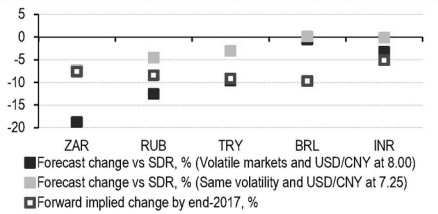
- The most vulnerable currencies to RMB depreciation are ZAR, RUB and TRY (Chart 58). The impact of RMB depreciation on BRL and INR is small. This is probably due to stronger idiosyncratic factors for BRL and INR in recent years.
- An increase in market volatility associated with USD/CNY rising to 8.00 would raise the depreciation of EM FX by 1ppt (BRL)-11ppt(ZAR) relative to our 7.25 baseline.
- In our base case of USD/CNY rising to 7.25 by end-2017, the market is overpricing depreciation pressures from the RMB on EM currencies. This partly reflects other factors have more sway over market expectations at the time of writing, such as implications of the US elections outcome.
- In our risk case of USD/CNY rising to 8.00 and high volatility, there is room for additional depreciation in the ZAR and RUB (Chart 58).

Chart 58: EM FX sensitivity to RMB and market volatility



Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 59: Scenario analysis of EM FX against market pricing



Source: BofA Merrill Lynch Global Research, Bloomberg

Can bond and equity inflows save the day? Not in the near term

Given the problematic issue of capital outflows and limited efficacy of moderate capital flows, another solution could be to attract more foreign portfolio inflows into China's sizable bond and equity markets. More favorable investment policies geared to overseas investors investing in China's interbank bond market reveal a clear policy intention to open up China's financial market. As a result, expectations are rising for China to be included in global bond indices. However, the following key obstacles for index inclusion remain, although reasons vary depending on the index: 1) lack of full accessibility: currently qualified investors only include medium and long-term investors while hedge funds are excluded; 2) insufficient clarification on requirements of fund remittance; 3) lack of clarification on tax issues; 4) lack of accessibility to onshore FX/rates hedging tools. Back from our 2016 China Conference, we believe allowing foreign private investors to access onshore repo, onshore FX swap and forwards would be the next steps to follow.

[1] Our dependent variable is the weekly changes of SDR/EM; our independent variables are the weekly changes in the SDR/EUR, SDR/CNY, SDR/USD and the VIX index, and a constant. Natural logarithms were taken for all variables and our sample period is Jan'14-Nov'16, when the start of the RMB depreciation trend. We base our currencies against the SDR to define their value (See Assessing China's Exchange Rate Regime, Frankel and Wei (2007) for a detailed explanation.). To compute the forecast change in each currency, we use our global FX forecasts to obtain our independent variables.

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The most influential global bond index is believed to be the Citibank World Government Bond Index (Citi WGBI), which is used as the benchmark for more than $2tn of AUM. The most influential EM bond index is the JPM Government Bond Index – Emerging markets Global/Diversified (JPM GBI-EM Global/Diversified), which is used as the benchmark for about $200bn AUM and caps each country's share to 10%. A caveat, however, is that the actual size of indexed money or ETFs should be smaller. The most crucial country criteria of Citi WGBI is "fully accessible to foreign investors," which makes China less likely to be included by far given its accessibility to only medium- and long-term investors. Even if China is being considered, the assessment usually takes a long time. So we believe the case for China to be included into Citi WGBI in 2017 is unlikely.

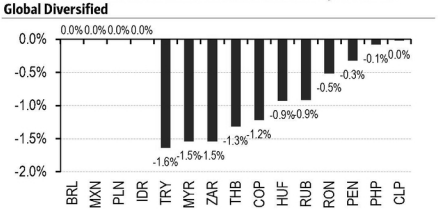
By contrast, JPM GBI-EM Global/Diversified only requires accessibility to the majority of foreign investors and does not factor in tax hurdles in eligibility. We believe China has better chance to be included into the JPM GBI-EM Global/Diversified index. While the exact timing is hard to predict, an optimistic scenario possibly leaves 2H17 on the table. Usually when a big country is being included, bonds are introduced slowly over many months to enable clients to rotate without too much disruption.

We would expect China's inclusion to account for 10% of the JPM GBI-EM Global Diversified index. Turkey, Malaysia, S. Africa, and Thailand would lose the largest shares in the index, while the shares of Brazil, Mexico, Poland and Indonesia are expected to remain given their large absolute size. Inflows to China could be around $20bn, or equivalent to 1.5% of the aggregate central government bond market cap. Turkey, Malaysia, S. Africa, Thailand and Columbia could see outflows of $2.4bn-3.3bn each, with the most expected impact on Thailand given its lower relative foreign ownership. We would expect China to account for 4.4% of the Citi WGBI index. The biggest losers of market share will be the US, followed by Japan and Europe. Inflows to China could be around $87bn, or 6.5% of its CGB market cap. This would present a very bullish scenario for CGBs, and the curve will likely steepen.

MSCI inclusion – more about good will, then real flow

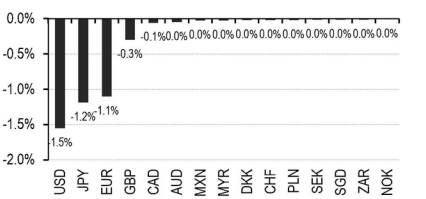
Another potential implication of China capital account opening is equity inflows. The MSCI has been considering the inclusion of China A-shares in its index. These are shares of local Chinese companies trading at the Shanghai and Shenzhen stock exchange, whose trading is so far limited to local investors (China: Will A-shares be included in MSCI in June this year?). The associated flows aren't likely to be too large, so positive price reaction is likely to come mostly from sentiment. The MSCI has discussed most recently a 5% inclusion factor for A-shares, which would translate in an additional 1.1% MSCI weight of China in the index. The scope for additional foreign capital looks small, when considering that China already weighs 27% in the index. Our equity strategists estimate the total AUM tracking MSCI EM to approximately USD1.6tn (total market cap of the index is USD3.8tn), so that inflows upon inclusion would be roughly USD16bn. The inclusion was delayed in June 2016, mainly due to obstacles regarding the quota allocation process, capital mobility restrictions and beneficial ownership.

Chart 60: Estimated loss of share if China is included in JPM GBI-EM Global Diversified



Source: BofA Merrill Lynch Global Research

Chart 61: Estimated loss of share if China is included into Citi WGBI



Source: BofA Merrill Lynch Global Research

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Carry trades and blond swans

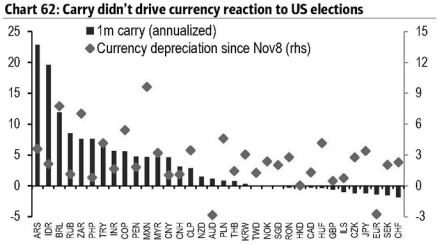
- We do not expect traditional carry trades such as ARS and BRL to perform well in a strong USD and increasing interest rates environment, so we focus on USD neutral carry trades.
- We like short EUR/RUB, short SGD/INR and long PEN/CLP. For more neutral commodity exposure we like baskets of EUR, CAD, COP and CLP, AUD to fund RUB and PEN trades respectively.

Carry is in the eye of the beholder

To focus on identifying best carry trades in the current environment of rising US interest rates sounds counterintuitive at least. It is well know that carry trades perform nicely in risk-on periods as well as in a low volatility environment, which is the opposite of what we expect in the coming months. However, once proper factor exposure of currency returns is considered, smart carry reemerges as an interesting proposition. As we have documented (Forecasting with Compass30), most of the variation in currency returns can be explained by the first two principal components, which can be labeled as dollar and carry factor respectively, as they are highly correlated with USD and carry performance.

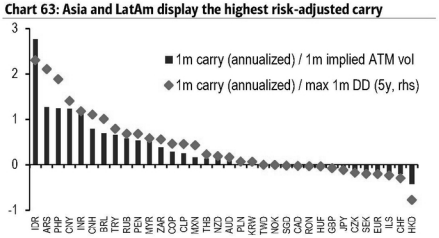
Expected returns of carry strategies are defined by interest rate differentials (ie, carry), assuming no change in spot exchange rates. Uncovered interest parity states that the carry should be offset by a change in the spot of equal magnitude. However, empirical evidence (so called forward premium puzzle) clearly shows that carry trades are profitable on average, which indicates the presence of currency risk premium. Since both dollar and carry, are priced factors, any sensible carry strategy in an environment in which US rates are rising needs to hedge the USD exposure. This is just a necessary though not a sufficient condition, since the carry factor is also correlated with global measures of risk. Interestingly, post-election currency losses is not as highly correlated with carry, indicating that carry trades were not as a strong investment theme as it was the case during the taper tantrum episode (Chart 62).

Chart 62: Carry didn't drive currency reaction to US elections



Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 63: Asia and LatAm display the highest risk-adjusted carry



Source: BofA Merrill Lynch Global Research, Bloomberg

Bank of America Merrill Lynch

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Characterizing carry

Efficient carry strategies involve buying and selling dynamic portfolios of currencies with certain risk characteristics. Carry strategies are supposed to work better over long investment horizons, so that the cushion provided by the carry compensates for the currency volatility through mean reversion.

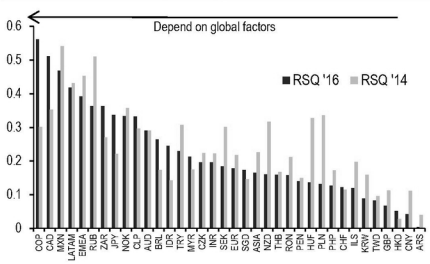
Here, we analyze carry from a different perspective, as our goal is to identify standalone attractive carry opportunities. We define the investment horizon to end 1Q17. We sort currencies based on risk-adjusted carry. We then characterize the factor exposure of currency returns, isolating global and idiosyncratic sources of risks, in order to identify smart carry trades that are not highly exposed to a massive re-pricing of global factors, such as US rates, USD, commodity prices and global risk aversion. We identify carry trades that have low exposure to global factors, in particular the USD factor, and offer attractive risk-rewards.

Not surprisingly, purely based on carry considerations, EM currencies appear more attractive than DM ones, which are mostly candidates for funding currencies. However, carry trades returns are highly volatile, exhibit negative skewness and fat tails. Even controlling for different measures of risk such as volatility or maximum drawdown, and according to this criteria only, we find that EM currencies are the most attractive, in particular ARS, BRL in LatAm, RUB, TRY and ZAR in EEMEA and INR, IDR and CNY in Asia (Chart 63).

Even though volatility and drawdowns can be useful measures of risk, they don't say much about the exposure to different risk factors. Since carry trade strategies are usually very sensitive to global factors, we study the cross sectional exposure of currencies to key global factors: commodity prices, global risk aversion and US yields (as a proxy of global yields). We report the R2 of regressions of two years of weekly returns on the above mentioned global factors, for the last two years and the years 2013-2014 for the sake of comparison (Chart 64).

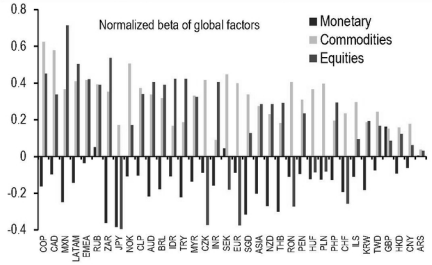
We find that currencies in LatAm and EEMEA are more exposed to global factors than in Asia. Interestingly, LatAm and EMEA currencies are more sensitive to shocks in commodity prices and risk aversion, while in Asia the shocks to monetary policy are the most important ones (Chart 65). Within DM currencies, AUD and NOK are the two currencies most exposed to global factors. Ideally, we seek for currencies with high risk-adjusted carry and low exposure to global factors. Under such a metric, ARS, BRL, RUB and INR stand out as the best investment currencies, while EUR, CHF, JPY, KRW and TWD are the best funding currencies. However, this filter is not enough in the current volatile environment.

Chart 64: LatAm is more exposed to global factors than Asia



Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 65: Sensitivity to global factors across regions



Source: BofA Merrill Lynch Global Research, Bloomberg

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The role of fundamentals

From a purely mechanical perspective, we could stop the analysis here and choose those currencies with better risk-reward prospects according to the metrics so far described. However, in order to analyze carry trades with relatively short investment horizon, we need to complement our analysis with our views on future exchange rates dynamics.

We expect US rates to continue moving higher and the USD to strengthen across the board due to easier US fiscal policy and significant uncertainty regarding foreign policy. In EM, we think LatAm is the region that will suffer the most in the new global scenario, followed by Asia. We find EEMEA relatively more resilient to US driven shocks. We want to avoid countries with high financing needs (i.e., high fiscal and current account deficits). We also prefer trades with neutral commodity exposure. Since carry trades tend to underperform when US rates are moving higher and the USD strengthens, we want at least to avoid USD funded carry trades, crowded carry trades and currency crosses highly exposed to the USD factor. Hedging the USD factor leaves us with the pure carry exposure, which by being a price factor, is also related to standard measures of risk, as well as idiosyncratic factors.

Best carry trade: Cherry picking among rotten cherries

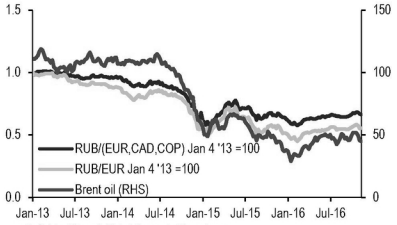
Given our views, and focusing on those trades where ex-ante high carry is consistent with ex-ante expected returns, we choose our best carry trades across EM and DM. Since DM currencies offer very low carry vs the USD, there are not many attractive carry opportunities in DM in a strong USD environment, so much so that the most attractive carry proposition is simply to go long USD/JPY. Since this trade is mostly predicated on a strong USD view and is being developed in other sections of this report we refer the reader to those sections (please see: USD/JPY will the main beneficiary of Trump win, FX: GOP sweep emboldens core USD/JPY view, Long EUR/JPYAsia: short JPY/KRW). Therefore, we focus mostly on EM or EM/DM carry trades.

EEMEA: short EUR/RUB

We like selling EUR/RUB (spot 69.28, target 66.15, stop 71.02). We see EEMEA as relatively more resilient to higher US rates, though with some heterogeneity within the region. On the one hand, high current account deficit countries like Turkey or South Africa should continue suffering from a re-pricing of risk. On the other hand, CEE countries are expected to some more resilience. One currency we find particularly attractive is the Russian ruble, which still offers an attractive risk-adjusted carry, controlling for standard measures of risk such as implied volatility and maximum drawdown. The outcome of the US election should remove some risk premium from Russian assets as the geopolitical backdrop improves. Economic activity is expected to pick up in 2017. A hawkish central bank, coupled with a favorable external position and an energy-driven current account surplus will likely limit its exposure to a reversal in capital flows.

On the geopolitical side, we expect Russian foreign policy to become more conciliatory

Chart 66: Oil prices are a major risk factor



Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 67: Russia tends to be more market-friendly with lower oil

Source: BofA Merrill Lynch Global Research, Bloomberg

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and less disruptive for markets, in particular given the expected improved foreign relations with the US (Chart 67). However, the currency remains overvalued and highly exposed to global factors, in particular oil price, and positioning is crowded. Despite our forecast is for USD/RUB to remain around 63 in 1Q17, we prefer to mitigate the above-mentioned risks by choosing a more favorable funding currency.

If liquidity is a major consideration, we prefer to use the EUR as a funding currency, which offers negative carry vs the USD, and gives the ruble the best risk-adjusted carry across all potential funding currencies. In addition to the already seen impact on US rates, Trump's victory implies that political risks are becoming increasingly important in Europe, with the Italian referendum in December and elections in Netherlands, Germany and France in 2017. This scenario strengthens our call for a six-month extension to ECB QE at the current pace. We expect the EUR/USD to trade at 1.05 by end 1Q17.

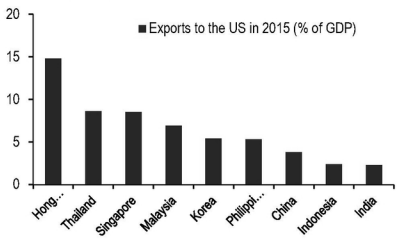
Since short EUR/RUB is still exposed to much lower oil prices, an alternative way to express the trade is to use a basket of euro, Colombian peso and Canadian dollar as funding basket (Chart 66). The COP remains overvalued, the central bank is expected to ease monetary policy as the economy decelerates and oil represents 35% of Colombian exports. We expect the COP to depreciate 2.5% by end 1Q17. Carry, on the other hand, is higher than EUR and CAD. The CAD offers very low carry and we forecast a 1.5% depreciation by 1Q17 vs the USD. The economy keeps displaying weak growth and we expect the Bank of Canada likely to cut rates and maintain the accommodative stance of monetary policy.

Asia: short SGD/INR

We like short SGD/INR (spot 47.96, target 47, stop 48.44). While the performance of Asia FX can be influenced by broader risk conditions, we expect most to weaken vs. the USD. The Korean won and the Singapore dollar, as well as the Taiwanese dollar for instance stand out as being the most sensitive to a stronger USD, as they act as a high beta proxy for CNY, which we expect to continue depreciating in this new high US rates environment. Others like Indonesian rupiah and Malaysian ringgit are more sensitive to higher USD rates. Consequently, outflows from these countries will adversely impact the respective FX. That said, Bank Indonesia has built good amount of reserves to prevent rupiah from weakening excessively. Moreover, tax amnesty related repatriation flows and global bond issuance is still expected to come in December, which should also support the rupiah.

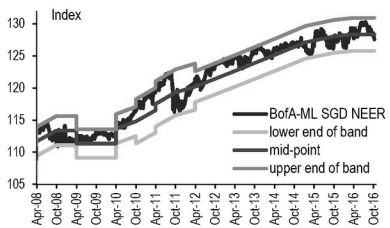
Historically, large US tax cuts have been followed by a widening of the US current account deficit driven by higher imports. This supported Asia export growth and exchange rates, especially after the Bush tax cuts. However, this time could be different partly because US household spending has been shifting towards non-tradable services. More importantly, Trump's policy platform itself is geared towards reducing dependence upon foreign goods and services (Chart 68).

Chart 68: Export exposure to the US across EM Asia



Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 69: S$NEER has depreciated 50bp below par since Oct MPS



Source: BofA Merrill Lynch Global Research estimates, Bloomberg

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At this juncture, the Indian rupee seems to be the only one in the region that is expected to display a much lower sensitivity to US rates, outperforming others within Asia. We expect the Monetary Authority of Singapore to keep the SGD NEER in the weaker side of the band for the next few months, which reduces the downside risk for the trade (Chart 69). We like the INR as the preferred long, followed by the IDR, as they offer high risk-adjusted carry, central banks are interested in keeping their currencies stable, current account deficits are bounded, and the currencies are not expensive relative to long term fundamentals. The main risk of the trade is of higher oil prices, and considerable reversal of capital flows. Apart from that, a change in the behavior of Reserve Bank of India it terms of managing INR to accumulate international reserves is also a risk.

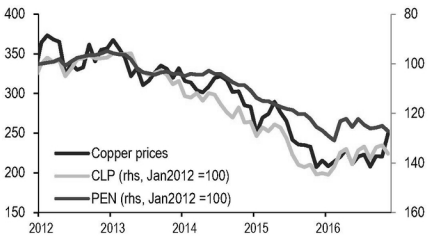
LatAm: long PEN/CLP

We like long PEN/CLP (spot 195.7, target 200, stop 195.5). LatAm is the most exposed region within EM to global factors. Traditional carry trade candidates like the Brazilian real and the Argentina peso are no longer attractive given the still fragile fiscal stance in both countries. Local positioning in BRL has proven to be heavier than thought, and we expect the currency to continue weakening until we observe some stabilization in US rates. The Brazilian real is still overvalued and the economy will be negatively affected since its strategy to gradually reduce budget deficits is based on low global rates, capital inflows and higher domestic growth. In the case of the Argentine peso, despite showing some detachment from global factors and some positive inflows due to the tax amnesty, we think the currency needs to weaken given the recent depreciation of the BRL and its current overvaluation as well as the government fiscal needs for 2017, which is an important electoral year. Therefore, we remain neutral on these currencies.

A more modest but more interesting carry trade within LatAm in an environment of higher US rates is to be long the Peruvian sol, funded with the Chilean peso, in order to make the trade more neutral to commodity exposure. The Peruvian economy is expected to continue growing at rates above 4% due to strong mining activity; the new government will likely implement expansionary fiscal policy and has room to finance it. The exchange rate is close to its equilibrium value based on terms-of-trade and productivity. In fact, we expect the currency to appreciate in real terms if growth recovers as predicted. The currency still offers a decent carry. We forecast a nominal depreciation but below the forward. The central bank has a strong preference for low currency volatility and would be ready to intervene in case of a disorderly depreciation, as it has been already the case in the last few days with small interventions in the forward market.

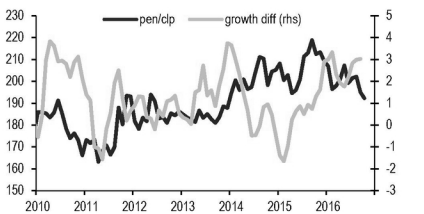
On the other hand, Chile's growth remains anemic and the economy is expected to continue growing sub 2% in 2017 (Chart 71). The CLP is overvalued but recent flows

Chart 70: Copper prices are a major risk factor



Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 71: Relative growth to favor Peru going forward



Source: BofA Merrill Lynch Global Research, Bloomberg, Haver

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from large domestic pension funds and the recovery in the price of copper explain the relative resilience of the currency (Chart 70). Given the low carry, CLP offers an attractive alternative as a funding currency as the portfolio rebalancing of pension funds is expected to slow down. We expect the currency to weaken further in 1Q17 as interest rates move higher in the US, and we do not expect the central bank to intervene, as it would likely be the case in Peru. In order to reduce the carry cost of the funding currency without losing the neutral exposure to metals, we like a basket of the Chilean peso with the Australian dollar. The Australian dollar is also highly correlated with commodities and China. We are bearish the AUD vs USD, as we expect the currency to weaken about 4% by end 1Q17.

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Cheapest tail-risk Hedges

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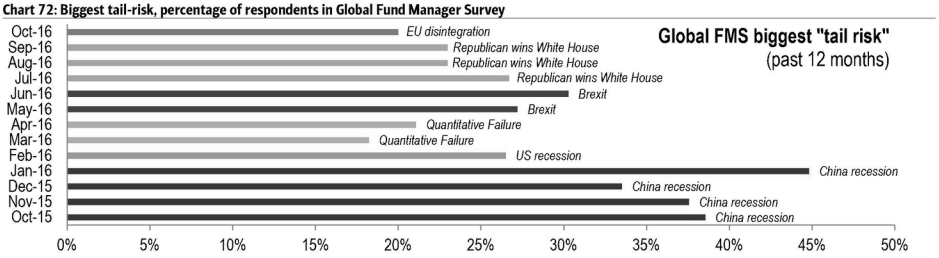
Tail-risk Hedges

- Four tail risks for 2017: 1) US deregulation, 2) EZ risk premia rises; 3) weaker bulk commodity prices; 4) steeper and more volatile yield curve in Japan.
- Position for normalization of swap spreads; 30s50s BTP flattener; long EUR/HUF vol; long AUD/USD digital puts; 1y10s20s conditional bear steepener in Japan.

There are three key lessons on tail risks from 2016: 1) tail-risk probabilities are generally "fatter" than commonly assumed (Brexit and Trump's victory); 2) hedging tail risks even in a world of low implied volatilities is hard if the directional implications are unclear (equity puts for a Trump victory); 3) investors worry about tail risks closer to the events – Chart 72 shows the biggest perceived tail risks, according to our Fund Manager Survey, were either during the event itself (China recession worries alongside capital outflows) or at most a few months in advance (Brexit and the US election).

Looking ahead to 2017, we believe tail-risk hedging will be more important than ever, but that investors should be sufficiently forward looking and focus on those where there is clarity about the directional implications. We highlight four such opportunities in this section, specifically: 1) US deregulation; 2) return of Euro zone risk premia; 3) China-linked commodity prices weakening sharply; and 4) Japan's yield curve targeting triggering a steeper curve and volatility increase.

Chart 72: Biggest tail-risk, percentage of respondents in Global Fund Manager Survey



Source: BofA Merrill Lynch Global Research

Tail risk 1: US deregulation

Normalized swap spreads, cross-currency basis & coupon vs principal STRIPS

Deregulation is a key focus for the incoming administration, and Dodd-Frank is a major potential target. Paul Atkins, a former SEC commissioner under George W Bush, has been named to lead transition strategy on financial regulation. Atkins has been vehemently critical of Dodd-Frank since its inception, and in a statement to the Senate

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in 2011 called the law a calamity that increases business uncertainty and undermines growth. Under Atkins, the transition team posted a statement that it will be "working to dismantle the Dodd-Frank Act and replace it with new policies to encourage economic growth and job creation." At this point there are no details on what parts of Dodd-Frank are most likely to be repealed, but Republican financial policy leaders appear pro-markets and have flagged free movement of capital via open markets as the best policy for economic growth and risk transparency.

There are several dislocations across markets today that we think have a chance of normalizing in the tail-risk event that deregulation results in increased availability of leverage and ability to take more risk. We have discussed these dislocations as resulting in part from the lack of ability of hedge funds and other relative-value traders to access enough balance sheet at a low enough cost to help these trades normalize. The top trades we could see benefitting from the return of leverage would be:

- Normalization of swap spreads; balance-sheet intensive Treasuries, both nominal and TIPS, are very cheap versus OIS and Libor swap rates.
- Normalization of cross-currency basis swaps, which currently allow USD-based investors the ability to buy very cheap EUR- and JPY-denominated assets via the basis swap.
- Normalization of coupon STRIPS versus principal STRIPS as these yield differentials are near their all-time wides, particularly in the 2030-38 maturity bucket.

As a tail risk for deregulation, we like buying 30y swap spreads, a credit-risk-free floating-rate US Treasury asset that provides 3m Libor + 56bp annually, which is about 100bp cheap to pre-crisis levels. Swap spreads could also benefit from deregulation that removes cash and Treasury bonds from the leverage ratio requirements, which would provide the ability of the dealer community to more easily absorb Treasury supply in the primary and secondary markets.

The main risk is that policy changes retain strict capital requirements, which would continue to limit the availability of leverage. For example, the Financial Choice Act, a product of Texas Representative Jeb Hensarling's team, would provide banks an off-ramp option to all Basel 3 requirements as long as banks hold a 10% capital ratio. This plan would probably decrease the availability of leverage, and could also result in reduced demand for short-dated Treasuries in HQLA portfolios. Another risk to 30y swap spread normalization in particular would be a material increase in deficit spending as part of a fiscal stimulus package. This would likely further cheapen Treasuries versus swaps and other benchmark interest rates.

Trade recommendation: Buy 30y Treasuries versus 30y matched Libor swap at 3mL+56bp. Target 3mL + 0bp, stop loss 3mL+75bp.

Tail risk 2: Comeback of Eurozone risk premia

EZ risk hedges: 30s50s flatteners in BTPs, buy EUR/HUF vol

In Europe, the biggest market risk for 2017 is arguably a comeback of stress on peripheral sovereigns. The next 12 months provide plenty of triggers, with increasing concerns about the ability of ECB to continue with QE, and an intense political season ahead (referendum in Italy on 4 Dec, and elections in France and Germany in 2017).

As hedges to Eurozone risks, we recommend buying 30s50s flatteners in BTPs as the cheapest way to express a bearish view on the periphery, and buying EUR/HUF vol as a proxy for Euro instability with better pricing than EUR/USD vol.

Concerns on EU politics and the ECB would likely lead to a switch of market focus from monetary policy to fundamentals. The periphery would be hurt by this new focus: public debt to GDP remains very high, and the low debt service costs enjoyed in the past five years favored debt accumulation, rather than debt reduction (Chart 73). The cyclical

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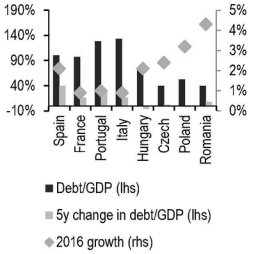
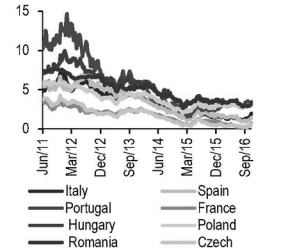
Chart 73: Fundamentals – CEE beats periphery



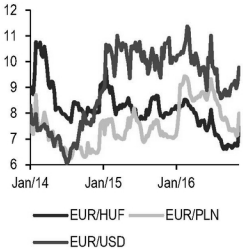
Source: IMF

Chart 74: Poland and Hungary wide relative to Italy and Spain



Source: Bloomberg

Chart 75: HUF vol lagging EUR and PLN



Source: Bloomberg.

juncture has also weighed on public finances, and all peripheral countries are running deficits above the structural levels.

The fundamental picture is not reflected in interest rate dynamics. ECB easing has pushed Eurozone interest rates lower despite worsening public finances (Chart 74). Participation in the QE program has been a strong determinant of low long-term rates, as shown by the tightening of the periphery vs CEE. Hungary, Poland and Romania have been yielding 3-3.5% in the past year, while Italy remained constantly below 2%. If stress comes back, the gap will close.

Within the periphery, Italy is the most vulnerable. Fundamentals are the worst in the region, only comparable to Portugal, which trades 160bp above it. Political risks also remain high, with the referendum providing some downside risk to the prime minister. The market is apparently reaching the same conclusion: during the most recent global bonds sell-off (20 Sep-14 Nov), Italy widened 95bp, while Spain widened 70bp, in line with CEE, despite the higher beta nature of the latter and the higher FX risk. Still, there may be room for further widening: the 10y spread to Germany widened in the current move, but is still lower than it has been the three years following the latest Italian political crisis. Our European rates team argued this summer that the rally in Italy spreads was far from fundamental. Flatteners in the 30s50s area look the best hedge as 50y are not eligible for QE, and term premia in the 2-31y sector would increase if QE was to end. Also, in times of sovereign debt stress, the curve tends to invert, further supporting long-end flatteners. Total carry is 1bp per month, making it cheaper and less sensitive to timing of stress than an outright short bond position.

On further EZ stress, the euro would weaken and euro vol rise. While a less dovish ECB would be euro-positive, peripheral stress would ignite concerns on the monetary union, and ultimately weaken the euro (as in Dec 2011). A cleaner hedge is buying EUR/HUF vol, as it proxies EUR/USD vol but has moved less so far. HUF options are historically very reactive to EZ stress, but the increase in vol lagged EUR/USD post-elections, and EUR/PLN vol has been higher in the past two years due to higher perceived risks in Poland (Chart 75). In Dec 2011, the vol spike in the three crosses had been the same.

CEE rates tend to widen in times of Eurozone stress, but their fundamentals are much more solid, so further EZ stress may bring opportunities to buy dips. CEE capitalized the past five year much better, with fiscal consolidation in Hungary, balanced budget in Czech Republic, and low debt/GDP ratios in Poland. Also, the growth picture is much more rosy, making leverage much more manageable.

Trade recommendation: Buy 50y BTPs vs 30y BTPS at 30bp, targeting ~8bp and with stop at 55bp. Risk is ECB QE continues and peripheral risk premium stays low.

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Tail risk 3: China-led commodity weakness

Commodity collapse hedge: buy AUD/USD 6m 0.67 digital put

Metal and bulk commodity prices have skyrocketed in anticipation of infrastructure spending in the US, We are wary of this rally: tax cuts are likely to be the first line of fiscal stimulus and potentially easier to get through Congress than sizeable infrastructure spending, which in any case will take a longer time to impact commodity demand (allowing for supply adjustments). Perhaps most importantly, China is still the swing factor for global commodity prices and the risks here remain to the downside.

The recent dramatic rise for China-linked bulk commodity prices, especially coal, has been driven by a combination of supply and demand imbalances (China floods, pit closures and inventory shortages) and an apparent rise in speculative activity in futures markets that has already drawn attention from regulators (Chart 76). Our resource analysts have raised forecasts but still see moderation over 2017 (Chart 77). The futures forward curve has already moved into backwardation. We see iron ore prices back at USD50/t in 2017 compared to a current spot price of USD74.

While global reflation might be positive for commodities, there are reasons for caution:

- We expect Chinese property investment, the most commodity-intensive sector of the economy, to slow in 2017.
- Sizeable RMB depreciation would be an additional deflationary impulse for industrial commodities.
- There will be a supply response as current prices bring uneconomic producers back on line, admittedly with a lag.
- There is potential for trade friction to impact regional trade while higher US rates are already impacting regional EM currencies. Australia is especially exposed to intra-regional trade and resource demand from the region.

Persistent supply/demand imbalances ahead of Chinese New Year might delay commodity weakness until after 1Q17, especially for coking coal due to a preference for thermal coal supplies over the Chinese winter. However, the risk of a sharp reversal beyond is worth hedging against given the demand dynamics in China, most obviously through the AUD. While short-dated implied volatility rose following the US election, the risk-reversal skew remains high as a percentage of implied volatility relative to G10 pairs. This suggests hedging via AUD/USD digital puts is appropriate, in our view.

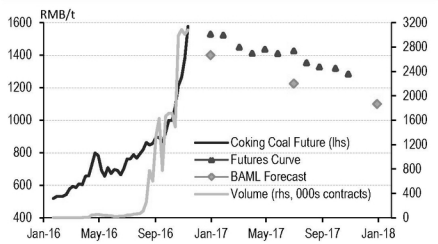
Trade recommendation: Buy 6m AUD/USD 0.67 digital put, entry: 10% (spot reference: 0.7550). Risk is global demand recovery provides support to commodity prices.

Chart 76: Bulk commodity spot prices

Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 77: China Coking coal futures and BAML forecasts

Our 2017 forecasts for Liulin No.4 Coking coal are averages for 1H and 2H



Source: BofA Merrill Lynch Global Research, Bloomberg

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Tail risk 4: BoJ triggers curve steepening and vol rise

BoJ keeps yield curve anchored out to 10y: 1y10s20s conditional bear steepener

The Bank of Japan (BoJ) has faced a tough 2016. Having switched its policy target from quantity to interest rates at its September Monetary Policy Meeting, it tacitly acknowledged that negative rates and JGB purchases were potentially approaching their limit in terms of policy effectiveness. Inflation expectations fell and the yen strengthened as a consequence as the market got accustomed to fading dovish pronouncements from the Bank of Japan. BoJ Governor Haruhiko Kuroda himself said "Central banks are, admittedly, not omnipotent."

The BoJ introduced yield curve control, taking into consideration negative effects of great decline in yields and curve flattening on financial institution earnings or financial markets. If the BoJ keeps purchasing at the current rate, however, yields will sooner or later feel downward pressure. We believe the BoJ is likely to reduce its long-term JGB purchase gradually. For the time being, JGB yield guidelines are probably around 0% for the 10yr, 0.4% for the 20yr, and 0.5% for the 30yr JGB.

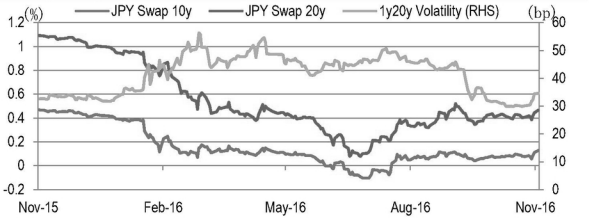
However, the BoJ appears to be concerned about the deterioration of financial institution earnings caused by flattening of the yield curve. Kuroda said that even if superlong-term yields rose slightly, he did not believe they would have to be lowered. He went on to say he was also giving consideration to investors in superlong-term bonds, and that he did not think it was good for the yield curve to get continually flatter. Based on these and other remarks, we expect long-term JGB purchase operations to be reduced and the curve to gradually steepen (Rates forecast: Attention on BoJ operations when yields decline).

Before that can happen, however, preconditions most likely include steady progress in US rate hikes, avoidance of excessive yen appreciation, and some degree of recovery in the inflation rate. With a Republican clean sweep, US fiscal easing is now a foregone conclusion and "Higher rates and higher dollar" may support our view for yen rates. If JGB purchase operations were reduced and yen rates rose in the wake of higher US Treasury yields and USD/JPY appreciation, that could easily be explained by fundamentals.

Yen rates volatility is still low; however, purchasing cuts by the BoJ could add to volatility risk amid declining liquidity in the super long-end (Chart 78). Even if risk-off sentiment pushes down the yield curve, the BoJ may lower the 10yr JGB yield target from zero to keep the curve steep. This kind of policy change also could increase volatility. In either case, the 10yr is expected to be anchored and movement is expected in the long end. We believe 1y10s20s conditional bear steepener may mitigate this risk.

Trade recommendation: Long 5bn 1y20y @0.62% (atm+11bp) payer vs Short 9.9bn 1y10y @0.18% (atm) payer. This position is zero cost, PV01 neutral, and zero carry. Risk is the curve remains flat due to a deflationary backdrop.

Chart 78: JPY Swap 10y and 20y rate and 1y20y volatility



Source: BofA Merrill Lynch Global Research

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Best Technical Trades

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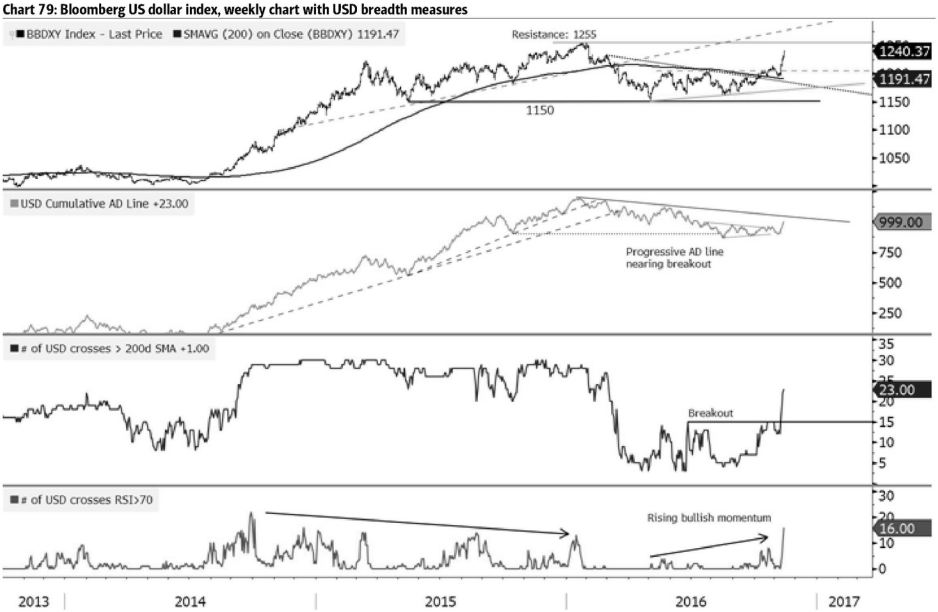
Technical trends for Trump

- Bullish USD: Breadth and technicals favor USD. Overall they point to a stronger US dollar in 2017. We are bullish USD/JPY.
- Higher yields: US 10y and 30y yield made large wedge bottom patterns, pointing to a 61.8% Fibonacci retracement of 2.98% and 3.80%, respectively.
- We recommend buying a NZD/USD 5m .69/.66 put spread 1x1.5 for 43 USD pips (off of .7100 spot).

USD rally is turning into an outright bull

The Bloomberg US dollar index is approaching all-time highs. The number of USD crosses above their 200-day moving average has broken out higher. The number of USD crosses reaching overbought on RSI (bullish momentum) continues to rise. The USD cumulative advance-decline line recently signaled for tactical USD strength and would turn outright bullish with a trend line break and new index highs.

Chart 79: Bloomberg US dollar index, weekly chart with USD breadth measures



Source: BofA Merrill Lynch Global Research, Bloomberg

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Bullish USD/JPY

The election of Donald Trump catapulted USD/JPY through another resistance level, this time a weekly trend line, adding to the list of technical signals that USD/JPY has bottomed and is in an uptrend. We began discussing a bottom in our September 5 and September 18 Technical Advantage reports. We estimate technical upside and resistance in the area of 112. We also think this uptrend has the potential to reach the full measured move target of 116.50 in 2017.

Chart 80: USD/JPY weekly chart

Source: BofA Merrill Lynch Global Research, Bloomberg

A higher yield environment

We continue to think yields will trend higher in 2017. We initially reported our view that global yields would rise in our October 26 Technical Advantage report. Since then we have seen added confirmation by US 10y, US 30y, 10yr bund, 30yr JGB and 10y Gilt that yields will rise.

US 10y and 30y yield form wedge bottom pattern

US 10y and 30y yields formed wedge bottom patterns by breaking through the upper trend line resistance (Breakout 1). A wedge pattern is composed of two converging trend lines often consisting of multiple smaller trends followed by a breakout. Each yield has a second resistant trend line and Fibonacci retracement to break. If 10y yield breaks through 2.35% and 30y yield through 3.15%, then another breakout will have occurred that technically triggers another leg higher to 2.98% and 3.80%, respectively. We think this is the more likely outcome.

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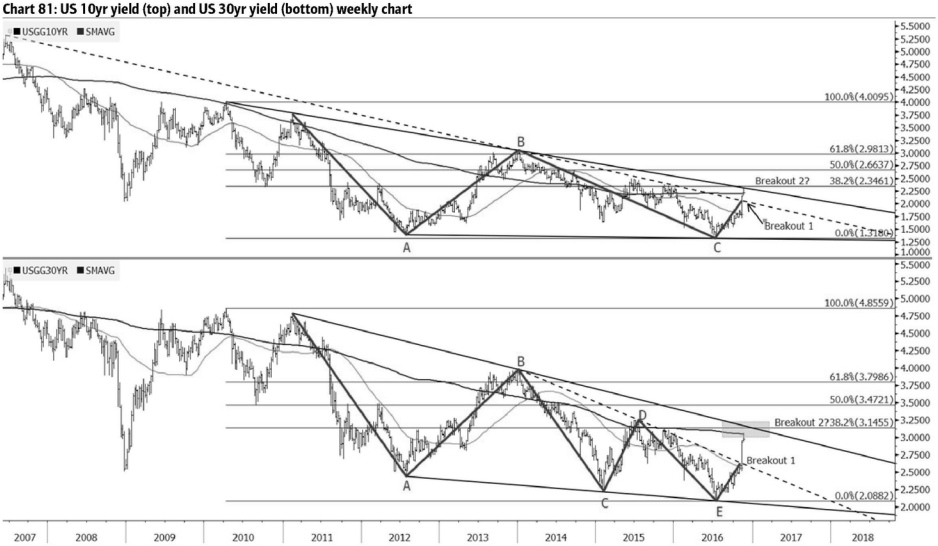
Chart 81: US 10yr yield (top) and US 30yr yield (bottom) weekly chart



Source: BofA Merrill Lynch Global Research, Bloomberg

German 10yr bund yield breaks out

Bund yield has risen through resistance levels and is up about 60bps from the low. Prior uptrends failed at trend line resistance levels; however, this time it broke through. The distance traveled during prior moves include +140bps, +93bps and +108bps. Therefore, we believe this uptrend has room to continue to 55bps (estimated 200wk SMA) by 1Q2017 and to 75bps in 2017.

Japanese 30y yields form head and shoulders bottom

The rapid decline in 30y JGB yield during 2016 led to a trend exhaustion signal at the lows (TD Sequential 13), a rise resulting in the most overbought (higher yield) momentum since 2010 and the formation of a head and shoulders bottom. Provided yield remains above 44bps, we could see yield rising to 71bps and possibly 87bps in 2017.

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Chart 82: German 10yr bund yield – weekly chart

Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 83: Japanese 30yr yield - weekly chart

Source: BofA Merrill Lynch Global Research, Bloomberg

Buy NZD/USD 5m .69/.66 put spread 1x1.5

NZD/USD is forming a head and shoulders top. It is breaking trend line support from the January to June lows. It is also threatening to break the neckline at .7070. MACD recently crossed bearish and is trending toward negative. This pattern suggests NZD/USD will decline as low as .6615. Given the strong USD move in G10 thus far, we think NZD/USD is near an attractive technical level to position for further USD strength. We recommending buying a NZD/USD 5m .69/.66 put spread 1x1.5 for 43 USD pips (off of .7100 spot).

Chart 84: NZD/USD daily chart

Source: BofA Merrill Lynch Global Research, Bloomberg

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Bond Yield Forecasts

Table 7: Quarter-end bond yield forecasts

		Latest	*4Q16*	*1Q17*	*2Q17*	*3Q17*	*4Q17*
USA	3m Libor	0.91	1.05	1.05	1.25	1.30	1.50
	2y T-Note	0.98	1.10	1.35	1.50	1.60	1.65
	5y T-Note	1.64	1.85	2.10	2.15	2.20	2.25
	10y T-Note	**2.21**	**2.35**	**2.55**	**2.60**	**2.65**	**2.65**
	30y T-Bond	2.95	3.10	3.30	3.30	3.35	3.35
	2y Swap	1.23	1.30	1.53	1.66	1.75	1.80
	5y Swap	1.68	1.88	2.10	2.15	2.20	2.25
	10y Swap	**2.07**	**2.23**	**2.41**	**2.44**	**2.49**	**2.49**
Germany	3m Euribor	-0.31	-0.30	-0.30	-0.30	-0.33	-0.32
	2y BKO	-0.62	-0.60	-0.60	-0.55	-0.50	-0.45
	5y OBL	-0.34	-0.35	-0.30	-0.25	-0.20	-0.10
	10y DBR	**0.30**	**0.40**	**0.45**	**0.50**	**0.55**	**0.65**
	30y DBR	0.93	1.05	1.10	1.15	1.15	1.15
	2y Swap	-0.13	-0.14	-0.16	-0.13	-0.06	-0.02
	5y Swap	0.14	0.12	0.16	0.21	0.27	0.36
	10y Swap	**0.69**	**0.81**	**0.85**	**0.89**	**0.92**	**1.00**
Japan	3m Libor	-0.07	-0.03	-0.03	-0.03	-0.03	-0.03
	2y JGB	-0.17	-0.20	-0.20	-0.20	-0.20	-0.15
	5y JGB	-0.11	-0.15	-0.15	-0.13	-0.12	-0.10
	10y JGB	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	2y Swap	0.01	-0.07	-0.07	-0.07	-0.07	0.00
	5y Swap	0.04	-0.05	0.00	0.01	0.02	0.04
	10y Swap	**0.15**	**0.12**	**0.15**	**0.15**	**0.15**	**0.15**
U.K.	3m Libor	0.40	0.40	0.25	0.25	0.25	0.25
	2y UKT	0.22	0.20	0.20	0.20	0.20	0.20
	5y UKT	0.66	0.70	0.80	0.85	0.90	0.90
	10y UKT	**1.40**	**1.50**	**1.60**	**1.65**	**1.70**	**1.75**
	30y UKT	2.04	2.10	2.15	2.20	2.25	2.30
	2y Swap	0.67	0.65	0.65	0.60	0.55	0.50
	5y Swap	0.96	1.00	1.10	1.15	1.20	1.20
	10y Swap	**1.34**	**1.55**	**1.70**	**1.75**	**1.80**	**1.85**
Australia	3m BBSW	1.76	1.70	1.70	1.70	1.80	1.80
	2y ACGB	1.77	1.90	1.95	2.00	2.05	2.10
	5y ACGB	2.16	2.30	2.40	2.45	2.50	2.60
	10y ACGB	**2.66**	**2.80**	**2.95**	**3.05**	**3.10**	**3.10**
	3y Swap	2.22	2.00	2.10	2.15	2.20	2.20
	10y Swap	**2.81**	**2.95**	**3.10**	**3.20**	**3.25**	**3.25**
Canada	2y Govt	0.66	0.70	0.60	0.50	0.40	0.40
	5y Govt	0.94	1.00	0.90	0.80	0.70	0.70
	10y Govt	**1.52**	**1.50**	**1.40**	**1.40**	**1.35**	**1.35**
	2y Swap	1.00	1.04	0.94	0.84	0.74	0.74
	5y Swap	1.29	1.35	1.25	1.15	1.05	1.05
	10y Swap	**1.78**	**1.76**	**1.66**	**1.66**	**1.61**	**1.61**

Source: BofA Merrill Lynch Global Research

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Global FX Forecasts

Table 8: Quarterly forecasts – G10 currencies

	Spot	Dec-16	Mar-17	Jun-17	Sep-17	Dec-17	Mar-18	Jun-18	Sep-18	Dec-18
G3										
EUR-USD	1.08	1.08	1.05	1.02	1.02	1.05	1.06	1.07	1.08	1.10
USD-JPY	108	108	112	115	117	120	117	115	112	110
EUR-JPY	117	117	118	117	119	126	124	123	121	121
Dollar Bloc										
USD-CAD	1.35	1.36	1.38	1.40	1.41	1.43	1.43	1.41	1.40	1.40
AUD-USD	0.76	0.74	0.73	0.72	0.71	0.70	0.70	0.71	0.73	0.75
NZD-USD	0.71	0.70	0.69	0.68	0.68	0.67	0.67	0.68	0.70	0.71
Europe										
EUR-GBP	0.87	0.88	0.91	0.89	0.88	0.88	0.88	0.87	0.86	0.85
GBP-USD	1.24	1.23	1.15	1.15	1.16	1.19	1.20	1.23	1.26	1.29
EUR-CHF	1.07	1.08	1.09	1.10	1.11	1.12	1.12	1.13	1.13	1.15
USD-CHF	0.99	1.00	1.04	1.08	1.09	1.07	1.06	1.06	1.05	1.05
EUR-SEK	9.86	9.50	9.40	9.30	9.20	9.15	9.10	9.00	8.90	8.90
USD-SEK	9.14	8.80	8.95	9.12	9.02	8.71	8.58	8.41	8.24	8.09
EUR-NOK	9.08	9.00	8.90	8.80	8.70	8.60	8.50	8.50	8.40	8.40
USD-NOK	8.41	8.33	8.48	8.63	8.53	8.19	8.02	7.94	7.78	7.64

Forecast as of Nov-15-2016. Spot exchange rate as of Nov-15-2016. The left of the currency pair is the denominator of the exchange rate. Source: BofA Merrill Lynch Global Research

Table 9: Quarterly forecasts – EM currencies

	Spot	Dec-16	Mar-17	Jun-17	Sep-17	Dec-17	Mar-18	Jun-18	Sep-18	Dec-18
Latin America										
USD-BRL	3.43	3.60	3.65	3.70	3.80	3.90	3.90	3.90	3.90	3.90
USD-MXN	20.48	21	21.25	21.5	21.75	22	22.25	22.5	22.75	23
USD-CLP	670	670	685	700	715	730	740	750	760	770
USD-COP	3,124	3,150	3,200	3,250	3,300	3,350	3,400	3,450	3,500	3,550
USD-ARS	15.60	15.80	16.00	17.00	17.50	18.00	18.50	19.00	19.50	20.00
USD-VEF	9.99	10	31.1	31.1	84.8	84.8	84.8	84.8	84.8	84.8
USD-PEN	3.44	3.45	3.47	3.50	3.52	3.55	3.60	3.65	3.70	3.70
USD-UYU	28.70	29	30	31	32	33	34	35	36	37
Emerging Europe										
EUR-PLN	4.41	4.30	4.25	4.20	4.20	4.20	4.10	4.05	4.05	4.00
EUR-HUF	310	310	310	305	300	300	300	295	295	290
EUR-CZK	27.03	27	27	27	26.5	26	26	26	26	25.5
USD-UAH	25.91	25.8	25.8	25.8	25.8	25.8	25.8	25.8	25.8	25.8
USD-RUB	65.47	65	63	65	65	65	65	65	65	65
USD-ZAR	14.15	14.5	14.5	14.5	14.5	14.5	14.3	14.5	14.8	15
USD-TRY	3.27	3.15	3.1	3.15	3.2	3.2	3.2	3.25	3.25	3.3
EUR-RON	4.51	4.5	4.5	4.45	4.4	4.4	4.4	4.35	4.35	4.3
USD-EGP	15.47									
USD-ILS	3.84	3.85	3.85	3.85	3.85	3.85	3.85	3.85	3.8	3.8
USD-AED	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
USD-SAR	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
USD-QAR	3.64	3.64	3.64	3.64	3.64	3.64	3.64	3.64	3.64	3.64
Asian Bloc										
USD-KRW	1,170	1200	1200	1220	1250	1270	1270	1230	1210	1190
USD-TWD	31.85	32.1	32.4	32.7	33.1	33.4	33.4	32.8	32.5	32.3
USD-SGD	1.41	1.44	1.45	1.49	1.5	1.51	1.51	1.51	1.51	1.5
USD-THB	35.36	36	36.5	37.5	37.8	38.2	39	39	38	37
USD-HKD	7.76	7.76	7.77	7.78	7.79	7.80	7.80	7.80	7.80	7.80
USD-CNY	6.85	7.00	7.05	7.10	7.15	7.25	7.35	7.35	7.30	7.20
USD-IDR	13369	13700	13900	14200	14400	14600	14500	14500	14400	14200
USD-PHP	49.07	50.5	51	52	53	53.5	54	54	53	52
USD-MYR	4.34	4.41	4.45	4.55	4.65	4.71	4.68	4.68	4.6	4.5
USD-INR	67.69	68.25	68.1	68.5	69	70	69.5	69	68.5	68

Forecast as of Nov-15-2016. Spot exchange rate as of Nov-15-2016. The left of the currency pair is the denominator of the exchange rate. Source: BofA Merrill Lynch Global Research

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For detailed information regarding the risks involved with investing in listed options: http://www.theocc.com/about/publications/character-risks.jsp.

Valuation & risk

Brazil (BRAZIL)

We are Marketweight Brazil's EXD with currently wide spreads compensating for the risks. The political crisis concerns investors and growth has been weaker than expected. However, spreads are quite high compared to LatAm investment grades. There are positive and negative tail risks for growth, as a resolution to the political paralysis could bring confidence back up quickly and improve the economic backdrop. With this positive tail risk, and a stronger fiscal adjustment in 2016, economic recovery could start in 2Q16. On the downside, pressures on GDP could increase if the political scenario deteriorates further, with the government failing to approve fiscal measures and/or Brazil shifting to a heterodox policy.

Colombia (COLOM)

Spreads, which have widened this year adequately compensate investors for the risk, in our view, and leads us to our Marketweight view. Downside risks are a rapid inflation acceleration from pass-through effects, which would be a difficult problem for macroeconomic policy. Also oil price weakness raises risk of recession. Fiscal and external difficulties generate incentives to relax the fiscal rule. Upside risks are a rise in commodity prices and stronger than expected growth.

Mexico (MEX)

Mexico's tight spreads fairly reflect the better quality of Mexican debt compared to most of LatAm, in our view. We forecast Mexico's activity growth to remain in the 2-3% range. Downside risks are lower growth in the US, lower oil prices and slower domestic oil production. A disorderly normalization of US monetary policy is a risk to Mexico's financial stability as well. Upside risks are higher oil prices and stronger US growth.

Turkey (TURKEY)

We are Overweight as Turkey Eurobonds lagged peers due to heightened political noise during the summer. Since Moody's downgraded the sovereign, all negative impact of the attempted coup seems to be priced and we think that bonds offer value vs peers. Downside risks are stronger outflows than expected and heightened political noise. Upside risks include a generalized rally on the back of more positive global backdrop.

Analyst Certification

We, David Woo, Adarsh Sinha, Arko Sen, Claudio Irigoyen, Jane Brauer, Kamal Sharma, Mark Capleton, Paul Ciana, CMT and Ralf Preusser, CFA, hereby certify that the views each of us has expressed in this research report accurately reflect each of our respective personal views about the subject securities and issuers. We also certify that no part of our respective compensation was, is, or will be, directly or indirectly, related to the specific recommendations or view expressed in this research report.

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Disclosures

Important Disclosures

Credit opinion history

Brazil / BRAZIL

Sovereign	Date^	Action	Recommendation
Brazil / BRAZIL	12-Nov-2015	Initial	Marketweight

Table reflects credit opinion history as of previous business day's close. ^First date of recommendation within last 36 months. The investment opinion system is contained at the end of the report under the heading "BofA Merrill Lynch Credit Opinion Key."

Colombia / COLOM

Sovereign	Date^	Action	Recommendation
Colombia / COLOM	12-Nov-2015	Initial	Marketweight

Table reflects credit opinion history as of previous business day's close. ^First date of recommendation within last 36 months. The investment opinion system is contained at the end of the report under the heading "BofA Merrill Lynch Credit Opinion Key."

Mexico / MEX

Sovereign	Date^	Action	Recommendation
Mexico / MEX	12-Nov-2015	Initial	Marketweight
	03-Dec-2015	Restricted	NA
	03-Dec-2015	Coverage Resumed	Marketweight
	21-Mar-2016	Restricted	NA
	21-Mar-2016	Coverage Resumed	Marketweight
	08-Aug-2016	Restricted	NA
	10-Aug-2016	Coverage Resumed	Marketweight

Table reflects credit opinion history as of previous business day's close. ^First date of recommendation within last 36 months. The investment opinion system is contained at the end of the report under the heading "BofA Merrill Lynch Credit Opinion Key."

Turkey / TURKEY

Sovereign	Date^	Action	Recommendation
Turkey / TURKEY	12-Nov-2015	Initial	Marketweight
	23-Feb-2016	Downgrade	Underweight
	17-May-2016	Upgrade	Marketweight
	27-Sep-2016	Upgrade	Overweight

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UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

----------X

VIRGINIA L. GIUFFRE,

Plaintiff,

v.

GHISLAINE MAXWELL,

Defendant.

15-cv-07433-RWS

----------X

Defendant's Response in Opposition to
Plaintiff's Omnibus Motion *in Limine*

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Dated: March 17, 2017

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UNITED STATES DISTRICT COURT
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VIRGINIA L. GIUFFRE,

Plaintiff,

v.

GHISLAINE MAXWELL,

Defendant.

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15-cv-07433-RWS

Declaration of Laura A. Menninger in Support of
Response in Opposition to Plaintiff's Omnibus Motion *in Limine*

I, Laura A. Menninger, declare as follows:

1. I am an attorney at law duly licensed in the State of New York and admitted to practice in the United States District Court for the Southern District of New York. I am a member of the law firm Haddon, Morgan & Foreman, P.C., counsel of record for Defendant Ghislaine Maxwell in this action. I respectfully submit this Declaration in support of Ms. Maxwell's Response in Opposition to Plaintiff's Omnibus Motion *in Limine*.

2. Attached as Exhibit A is a true and correct copy of a statement on behalf of Ms. Maxwell dated January 2, 2015.

3. Attached as Exhibit B is a true and correct copy of an article by Sharon Churcher titled "Teenage girl recruited by paedophile Jeffrey Epstein reveals how she twice met Bill Clinton," DAILY MAIL, dated March 5, 2011.

4. Attached as Exhibit C (filed under seal) are true and correct copies of [redacted]

5. Attached as Exhibit D (filed under seal) are true and correct copies of [redacted]

6. Attached as Exhibit E (filed under seal) are true and correct copies of [redacted]

7. Attached as Exhibit F (filed under seal) is a true and correct copy of [redacted]

8. Attached as Exhibit G is a true and correct copy of an article by Sharon Churcher titled "The Prince, a paedophile and the sex slave teen" The Daily Telegraph, dated February 28, 2011.

9. Attached as Exhibit H (filed under seal) is a true and correct copy of [redacted]

10. Attached as Exhibit I is a true and correct copy of an article titled "Buckingham Palace issues second denial of underage sex claims against Prince Andrew," Fox News.com.

11. Attached as Exhibit J is a true and correct copy of an article titled "Prince Andrew denies sex abuse claims" CNN.com.

12. Attached as Exhibit K is a true and correct copy of an article by Tom Leonard titled "Prince Andrew risks ambassador job as underage sex case girl reveals meeting him" DAILY MAIL, dated March 2, 2011.

13. Attached as Exhibit L is a true and correct copy of an article by Wills Robinson titled "Jeffrey Epstein 'sex slave' Virginia Roberts was a 'money-hungry sex kitten', ex friends claim" DAILY MAIL, dated March 1, 2015.

14. Attached as Exhibit M (filed under seal) are true and correct copies of [redacted]

15. Attached as Exhibit N (filed under seal) is a true and correct copy of [redacted]

16. Attached as Exhibit O (filed under seal) is a true and correct copy of [redacted]

17. Attached as Exhibit P (filed under seal) are true and correct copies [redacted]

18. Attached as Exhibit Q (filed under seal) is a true and correct copy of [redacted]

19. Attached as Exhibit R is a true and correct copy of a press release in the *Edwards, et. al v. Dershowitz* matter, dated April 8, 2016, Bates stamped GM_00523-4.

20. Attached as Exhibit S is a true and correct copy of an Order Denying Motion to Join Under Rule 21, *Doe v. United States,* No. 08-80736-Civ-Marra/Johnson (S.D. Fla. Apr. 7, 2016).

I declare under penalty of perjury that the foregoing is true and correct.

Executed on March 17, 2017.

s/ Laura A. Menninger
Laura A. Menninger

CERTIFICATE OF SERVICE

I certify that on March 17, 2017, I electronically served this *Declaration of Laura A. Menninger in Support of Defendant's Response in Opposition to Plaintiff's Omnibus Motion in Limine* via ECF on the following:

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/s/ Nicole Simmons
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EXHIBIT A

From: <ross@acuityreputation.com>
Date: 2 January 2015 at 20:38
Subject: Ghislaine Maxwell
To: Rossacuity Gow <ross@acuityreputation.com>
bcc: martin.robinson@mailonline.co.uk,
P.Peachey@independent.co.uk,
nick.sommerlad@mirror.co.uk,
david.brown@thetimes.co.uk,
nick.alway@bbc.co.uk,
jo-anne.pugh@bbc.co.uk

To Whom It May Concern,
Please find attached a quotable statement on behalf of Ms Maxwell.

No further communication will be provided by her on this matter.
Thanks for your understanding.
Best
Ross

Ross Gow
ACUITY Reputation

Jane Doe 3 is Virginia Roberts - so not a new individual. The allegations made by Victoria Roberts against Ghislaine Maxwell are untrue. The original allegations are not new and have been fully responded to and shown to be untrue.

Each time the story is re told it changes with new salacious details about public figures and world leaders and now it is alleged by Ms Roberts that Alan Derschowitz is involved in having sexual relations with her, which he denies.

Ms Roberts claims are obvious lies and should be treated as such and not publicised as news, as they are defamatory.

Ghislaine Maxwell's original response to the lies and defamatory claims remains the same. Maxwell strongly denies allegations of an unsavoury nature, which have appeared in the British press and elsewhere and reserves her right to seek redress at the repetition of such old defamatory claims.

Sent from my BlackBerry® wireless device

EXHIBIT B

Teenage girl recruited by paedophile Jeffrey Epstein reveals how she twice met Bill Clinton

By Sharon Churcher and Polly Dunbar for MailOnline
Updated: 19:53 EST, 5 March 2011

As a New Yorker from humble beginnings, Jeffrey Epstein played on his blue-collar credentials and enormous wealth to extend tentacles of influence throughout America's liberal political elite.During the outcry over the Epstein case, it emerged that another man with a notorious appetite for young women, Bill Clinton, travelled with Epstein to a number of destinations, including three times on the billionaire's private aircraft.On one occasion, Epstein flew the former President, Hollywood actor and staunch Democrat Kevin Spacey and another actor friend of Mr Clinton's, Chris Tucker, to Africa, to 'discuss AIDS policy'.

GM_00715

Claims: Virginia Roberts says she twice met ex-president Bill Clinton, pictured last month, but was never 'lent out'

Epstein, who has donated more than £75,000 over the years to candidates from the Democratic Party, also flew with Mr Clinton in November 2003 to destinations including Russia, Oslo, Hong Kong, Shanghai and Beijing.

Yet Virginia Roberts stresses that she was never 'lent out' to Mr Clinton.

On one occasion, she adds, Epstein did invite two young brunettes to a dinner which he gave on his Caribbean island for Mr Clinton shortly after he left office. But, as far as she knows, the ex-President did not take the bait. 'I'd have been about 17 at the time,' she says. 'I flew to the Caribbean with Jeffrey and then Ghislaine Maxwell went to pick up Bill in a huge black helicopter that Jeffrey had bought her.

Share this article

Share'She'd always wanted to fly and Jeffrey paid for her to take lessons, and I remember she was very excited because she got her licence around the first year we met.

'I used to get frightened flying with her but Bill had the Secret Service with him and I remember him talking about what a good job she did.'I only ever met Bill twice but Jeffrey had told me that they were good friends.

'I asked, "How come?" and he laughed and said, "He owes me some favours." Maybe he was just joking but it constantly surprised me that people with as much to lose as Bill and [Prince] Andrew weren't more

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careful.'Bill must have known about Jeffrey's girls. There were three desks in the living area of the villa on the island.

Speaking out: Virginia, now aged 26, in her new home in Australia

'They were covered with pictures of Jeffrey shaking hands with famous people and photos of naked girls, including one of me that Jeffrey had at all his houses, lying in a hammock.'We all dined together that night. Jeffrey was at the head of the table. Bill was at his left. I sat across from him. Emmy Tayler, Ghislaine's blonde British assistant, sat at my right. 'Ghislaine was at Bill's left and at the left of Ghislaine there were two olive-skinned brunettes who'd flown in with us from New York.

'I'd never met them before. I'd say they were no older than 17, very innocent-looking. 'They weren't there for me. They weren't there for Jeffrey or Ghislaine because I was there to have sex with Jeffrey on the trip.'Maybe Jeffrey thought they would entertain Bill, but I saw no evidence that he was interested in them. He and Jeffrey and Ghislaine seemed to have a very good relationship. Bill was very funny.

'Bill must have known about Jeffrey's girls. There were three desks in the living area of the villa on the island... covered with photos of naked girls' 'He made me laugh a few times. And he and Jeffrey and Ghislaine told blokey jokes and the brunettes listened politely and giggled. 'After dinner I gave Jeffrey an erotic massage. I don't remember seeing Bill again on the trip but I assume Ghislaine flew him back.'According to prison records, when Epstein was serving his jail term, his visitors included a long-time – and highly controversial – Clinton acquaintance, Arnold Prosperi.

'In the final hours of the Clinton presidency, in January 2001, Prosperi was facing three years in prison after being convicted of tax fraud. Mr Clinton commuted his sentence to house arrest. 'Clinton, Prosperi and Epstein make an odd threesome on the face of it,' says a law enforcement source.'Was Prosperi visiting Epstein as some kind of intermediary for Bill?

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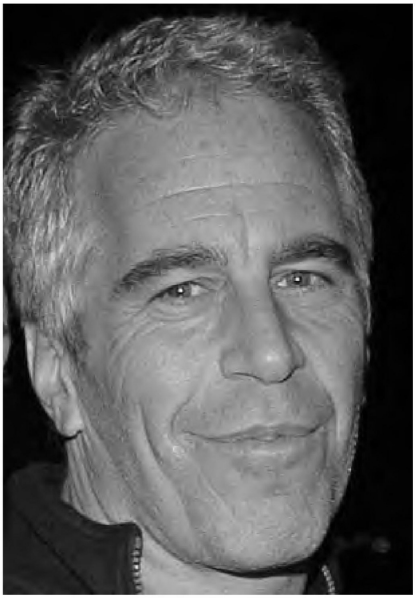
'Maybe Bill wanted to know if Epstein knew anything that could embarrass him. Or did Bill commute Prosperi's sentence as some kind of favour for Epstein?' Virginia disclosed that Mr Clinton's vice-president Al Gore and his wife, Tipper, were also guests of Epstein on his island.

Guests: Virginia says she also met former Vice President Al Gore, pictured right with Mr Clinton

Last summer, the Gores abruptly announced that they were ending their supposedly fairytale marriage and, just weeks later, it emerged that Mr Gore – the famously sanctimonious global-warming disciple – had been accused of trying to force sex on a woman with whom he had booked a therapeutic massage at an Oregon hotel. 'I had no clue that anything was up,' Virginia says. 'The Gores seemed like a beautiful couple when I met them. All I knew was that Mr Gore was a friend of Jeffrey's and Ghislaine's. Jeffrey didn't ask me to give him a massage. 'There might have been a couple of other girls there on that trip but I could never have imagined this guy would do anything wrong. I was planning to vote for him when I turned 18. I thought he was awesome.'Virginia said that yet another American liberal icon, President Obama's Middle East peace envoy Senator George Mitchell, frequently visited Epstein's New York residence. Mr Mitchell, aged 77 – who previously led America's Northern Ireland peace initiative – 'was very close to Jeffrey,' Virginia recalled. 'He is very clean-cut. You wouldn't think of him being part of Jeffrey's crew.'

GM_00718



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Scandal: U.S. authorities want to interview Jeffrey Epstein (left) and may wish to quiz his friend, Prince Andrew

Epstein's contacts book contains a work and a home telephone number for the senator. Another acquaintance was Israel defence secretary Ehud Barak, whose spokesman told The Mail on Sunday: 'Mr Barak did attend several small functions in Mr Epstein's home in New York that were usually attended by leading businessman, university presidents, Nobel Prize Laureates and prominent public figures.'Epstein's many Hollywood pals include Matt Groening, creator of The Simpsons.

'Jeffrey once had me give Matt a foot massage when he was flying on the jet with us,' Virginia says. 'He laughed and did drawings of Bart and Homer for my little brother and my dad.'I also met Naomi Campbell at a birthday party of hers on a yacht in the South of France. She is a friend of Ghislaine's but she was a real bitch to me.

'She was very fake. She turned away from me when we were introduced by Ghislaine and Jeffrey.'Donald Trump was also a good friend of Jeffrey's. He didn't partake in sex with any of us but he flirted with me. He'd laugh and tell Jeffrey, "You've got the life." 'Palm Beach Police say Epstein seemed utterly unfazed by the allegations against him when they began their long and detailed investigation.

'Jeffrey's crew: Middle East peace envoy George Mitchell, right, pictured with President Barack Obama and U.S. Secretary of State Hilary Clinton, frequently visited Epstein¿s New York residence, Virginia also claims

But he also took his defence very seriously indeed. Epstein engaged his friend, the Harvard law professor Alan Dershowitz – whose celebrity clients have included Mike Tyson, Patty Hearst, Claus von Bulow and O.J. Simpson – to run his legal defence. He also employed a firm of private investigators to

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investigate the backgrounds of the girls.Detectives painstakingly built a case which they believed showed that Epstein systematically paid teenage girls to recruit other teenage girls to his sex ring. However, as the investigation continued, they found that Epstein's team had already spoken to key witnesses, suggesting that the financier would reward those who helped him.In addition, Epstein's defence team agreed to the unusual move of suggesting that the alleged victims sue Epstein in the civil courts. The result was a plea bargain in which Epstein admitted a single charge of soliciting an underage girl for prostitution – a deal which infuriated many police officers who worked on the case.More than 20 of Epstein's girls are said to have sued him for damages. At least 17 have settled out of court.Mr Clinton, Mr Gore and Mr Mitchell were all contacted about their friendship with Epstein but declined to comment.

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EXHIBIT F

EXHIBIT G

The Daily Telegraph

News

The Prince, a paedophile and the sex slave teen

Sharon Churcher and Chelsea White, DailyTelegraph
February 28, 2011 6:00am

A MOTHER of three living in Australia has revealed she was a teenage prostitute flown all over the world by a convicted sex offender to meet Prince Andrew.

The revelations have rocked Buckingham Palace as the woman, Virginia Roberts, 27, confessed she was the minor identified in FBI and subsequent civil proceedings against wealthy financier and registered sex offender Jeffrey Epstein.

A photo of Epstein and the Duke of York, Prince Andrew, together last week compelled Ms Roberts to come forward.

First employed as a 15-year-old as Epstein's masseuse, she alleges he groomed her to become a prostitute, paying her for sex with him and his influential friends.

While Ms Roberts said there was never any sexual relationship between the Prince and herself, she claims that as a 17-year-old she met the Prince on three occasions - at one of which she was told to sit on his knee while he touched another woman's breast.

Pictures: Prince Andrew and Virginia Roberts

Latest from *Mail on Sunday*

Ms Roberts told London newspaper *The Mail on Sunday* she was first flown to England on a private jet to meet the Prince in March 2001.

The 17-year-old was told to dance with the Prince and even posed for a photograph.

For her time with Epstein and the Prince on that trip, Epstein paid her $US15,000.

When she next met the Prince in the US, a 21-year-old woman who was working for Epstein was sitting on Prince Andrew's knee. Ms Roberts said she was instructed to do the same while the Prince touched the older woman's breast as a "joke".

The FBI case revealed sexual allegations by at least 20 girls, however, Epstein struck a deal with prosecutors and served 13 months' jail for soliciting child prostitution.

Ms Roberts stayed working as Epstein's "masseuse" until she met an Australian martial arts expert named Robert.

The pair married, causing an enraged Epstein to cut off the then 19-year-old.

Ms Roberts said she was coming to grips with her exploitation. Three years ago she was contacted by the FBI who found photos and secret videos of her during their investigations.

The case forced Ms Roberts to deal with her abuse and also reveal it to her husband.

"I couldn't bring myself to tell him much. No man wants to know his wife has been traded out," she told *The Mail*.

While Epstein's plea deal meant her identity was hidden, Ms Roberts said after seeing a picture of the pair shopping she had to go public. "I am appalled. To me, it's saying 'We are above the law'. But Jeffrey is a monster." Both Epstein and Prince Andrew refused to comment.

Originally published as Prince Andrew and the sex slave teen

REDACTED
EXHIBIT H

EXHIBIT I

Buckingham Palace issues second denial of underage sex claims against Prince Andrew

www.foxnews.com/world/2015/01/04/buckingham-palace-issues-second-denial-underage-sex-claims-against-prince.html

June 6, 2012: In this file photo, Britain's Prince Andrew leaves King Edward VII hospital in London after visiting his father Prince Philip. (AP)

Buckingham Palace officials have again denied claims made by a woman who alleged that she was forced to have sex while underage with Prince Andrew, Duke of York.

The second denial comes after two Sunday papers in Britain published interviews with the woman in which she claimed that she was forced by American financier Jeffrey Epstein to have sex with Prince Andrew at least three times between 1999 and 2002. The woman alleges that the encounters took place in London, New York, and on a Caribbean island owned by Epstein.

A Palace spokesman has said that the allegations are "false and without any foundation."

"It is emphatically denied that the Duke of York had any form of sexual contact or relationship with (the woman)," the statement continued. The denials are unusual because royal officials typically do not comment on allegations against members of the royal family.

The woman's claims are part of a lawsuit in a Florida court relating to how prosecutors handled a sexual abuse case against American financier Jeffrey Epstein. The woman, identified in court papers only as "Jane Doe No. 3," is one of two new accusers asking a West Palm Beach, Florida, judge to allow them to join the existing lawsuit against Epstein. The royal is not named as a defendant in the case, and no criminal charges or formal allegations have been made against him.

The women have objected to how U.S. prosecutors handled Epstein's case, and want authorities to reconsider a plea deal that allowed Epstein to avoid much more serious federal charges and potentially longer prison time. Epstein served 13 months of an 18-month sentence after pleading guilty to a single charge of soliciting prostitution before being released in 2009.

It was not the first time Prince Andrew has faced media scrutiny over his friendship with Epstein. In July 2011 the royal stepped down from his role as a U.K. trade ambassador after he was photographed with Epstein in New York.

Prince Andrew is the second son and third child of Queen Elizabeth II and Prince Philip, Duke of Edinburgh. He is fifth in line to the British throne behind his older brother Prince Charles, nephew Prince William, grandnephew Prince George, and nephew Prince Harry.

The Sunday Mirror reported that Prince Andrew was on a skiing holiday in Switzerland, where he had been staying with his ex-wife Sarah Ferguson and their daughters, Princess Beatrice and Princess Eugenie.

In a further bizarre twist to the story, prominent attorney Alan Dershowitz, who is also named in the court documents, told the BBC that he is planning legal action against the woman.

"If she believes she has been hurt by me and Prince Andrew, she should be suing us for damages," the former Harvard Law professor said. "I welcome that lawsuit. I welcome any opportunity that would put her under oath and require her to state under oath these false allegations."

The Associated Press contributed to this report.

EXHIBIT J

Prince Andrew denies sex abuse claims - CNN.com

edition.cnn.com/2015/01/22/europe/prince-andrew-sex-abuse-allegations/

Story highlights

- Prince Andrew addresses crowd at Davos, backs palace statement
- Court documents show attorneys sent a letter asking to interview him under oath
- Buckingham Palace has strenuously denied claim that he had sex with Virginia Roberts

"Firstly, I think I must, want, for the record to refer to the events that have taken place in the last three weeks. And I just wish to reiterate and to reaffirm the statements which have already been made on my behalf by Buckingham Palace," he said Thursday at the World Economic Forum.

Earlier this month, Buckingham Palace issued a statement which said, "It is emphatically denied that the Duke of York [Andrew] had any form of sexual contact or relationship" with the woman. "Any claim to the contrary is false and without foundation."

Andrew is a son of Queen Elizabeth II and a brother of Prince Charles, the next in line for the British throne.

The prince is accused of having sex with the woman when she was 17, details of which are is a sworn affidavit in Florida court dated January 19. The woman said that she and the Prince had sex "three times, including one orgy."

The court documents showed that her lawyers had sent a letter to Buckingham Palace asking to interview the prince under oath.

In her sworn affidavit, the woman described Buckingham Palace's denial that sexual contact ever took place between the pair as "false and hurtful to me."

Interview request

The woman, identified by Buckingham Palace as Virginia Roberts, first named the prince in a civil motion filed December 30 in the U.S. District Court in southern Florida in which she claims she was forced to have sex with several men. She is referred to as Jane Doe No. 3 in the legal filings.

In the letter the woman's lawyers sent to Buckingham Palace, attorneys Paul Cassell and Bradley Edwards asked to interview Prince Andrew "under oath regarding interactions that you had with Jane Doe No. 3 beginning in approximately early 2001. Jane Doe No. 3 was then 17 years old."

The letter includes a picture of the woman and Andrew which was taken around that time, they say. The lawyers also want to discuss subsequent interactions with their client in New York City later that year, the letter says.

"The interview could be conducted at a time and place of your choosing, and with your cooperation, I believe the interview could be completed in two hours or less," it says.

New court pleadings involving the relationship between Jane Doe No. 3 and the prince are being prepared, the letter adds, but their filing will be delayed if Andrew accepts the interview request by January 19.

The attorney for her legal team confirmed to CNN that Buckingham Palace had refused to accept the letter to Prince Andrew and that it was returned to them.

Buckingham Palace didn't respond Thursday when asked by CNN about the letter.

But the woman's allegations have previously been firmly rejected by Buckingham Palace.

"It is emphatically denied that the Duke of York had any form of sexual contact or relationship with Virginia Roberts. Any claim to the contrary is false and without foundation," the palace said early this month.

Statement: I just called him 'Andy'

Prince Andrew is named in the court filing in Florida as one of a number of prominent people who allegedly had sexual contact with teenage girls through self-made billionaire Jeffrey Epstein, who pleaded guilty some years ago in Florida to a state charge of prostitution solicitation.

CNN was unable to reach Martin Weinberg, Epstein's attorney, on Thursday.

In her first sworn statement to the court, Jane Doe No. 3 gave more details of the alleged encounters.

"Epstein made me have sex with Prince Andrew several times," she said, according to the court document.

"I had sex with him three times, including one orgy. I knew he was a member of the British Royal Family, but I just called him 'Andy.' "

One day when she was in London, she said, Epstein told her she would be meeting a "major prince."

She continued: "Epstein told me 'to exceed' everything I had been taught. He emphasized that whatever Prince Andrew wanted, I was to make sure he got."

'Sexual interests in feet'

When the prince arrived, she was introduced, she said, and "we kissed formally, cheek to cheek." The group went for dinner and to a nightclub where she was served alcohol before returning to the townhouse. The picture referred to in the letter, of the prince with Roberts, was taken there, she said.

After the pair were left alone, she said, "We went to the bathroom and bedroom, which were just steps away from where the picture was taken. We engaged in sexual activities there. Afterwards, Andy left quickly with his security."

She said she had reported back to Epstein on the encounter next day, telling him, "It went great."

"I told Epstein about Andy's sexual interests in feet. Epstein thought it was very funny. Epstein appeared to be collecting private information about Andy," she added.

Roberts also gave details of two more alleged occasions when the pair had sex. One was in Epstein's New York mansion in spring 2001, she said, when she was 17.

The third and last occasion was at an orgy involving nine girls on Epstein's private island in the U.S. Virgin Islands, her statement said.

"I was around 18 at the time. Epstein, Andy, approximately eight other young girls, and I had sex together."

The other girls, who appeared to be under 18, were "European looking and sounding" and didn't really speak English, she said. She said she "felt disgusted" after the orgy.

'Voluntarily tell the truth'

Roberts rejected the palace's denial of the allegations and said she hoped Andrew would agree to be interviewed under oath. "I did have sexual contact with him as I have described here -- under oath," she said.

"Given what he knows and has seen, I was hoping that he would simply voluntarily tell the truth about everything."

Roberts and another woman are seeking to join two other women who are arguing in federal court for the U.S. government to reexamine its case involving Epstein.

The investment banker agreed to a state plea deal in 2007 and began serving an 18-month sentence in 2008, according to court documents. He pleaded guilty to solicitation of prostitution and procurement of a minor for prostitution.

CNN's Max Foster contributed to this report.

EXHIBIT K

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Daily Mail .com News

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Prince Andrew risks losing ambassador job as girl in underage sex case reveals meeting him

By TOM LEONARD
UPDATED: 00:07 EST, 2 March 2011

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- **The Duke of York, 51, pictured with his arm around the bare midriff of Virginia Roberts**
- **Mother-of-three spent four years as millionaire's personal masseuse**
- **Epstein trained her 'as a prostitute for him and his friends'**

Serious doubts are being cast on Prince Andrew's suitability to represent Britain following revelations that he spent time with a girl of 17 while she was being sexually exploited by one of his billionaire friends.

The Duke of York, 51, was pictured with his arm around the bare midriff of Virginia Roberts, a vulnerable teenager hired to work as an 'erotic masseuse' and perform sexual favours for American businessman Jeffrey Epstein and his friends.

Later, she claims, Epstein's friend Ghislaine Maxwell told her: 'You did well. He had fun.'

First meeting: Prince Andrew puts his arms around 17-year-old Virginia, centre

Andrew, who works for the Government as an ambassador for foreign trade, remains close to Epstein, 58, and stayed at his New York mansion as recently as December – despite the financier admitting to child sex crimes in 2008 and being placed on the US sex offender register.

But the full extent of the prince's proximity to Epstein's offences was not known until Miss Roberts broke her silence this weekend. In a civil writ against the businessman, she alleged that her duties included being 'sexually exploited by Epstein's adult male peers including royalty'.

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FEMAIL TODAY

- If you can't beat them, join them! Now it's Kate's turn to hit the bar as she swigs a pint of Guinness with William after his wild time partying in Switzerland
- Smoke break! Mary-Kate and Ashley Olsen enjoy a cigarette outside New York City office building after it's revealed one of them 'wants kids'
- How cheeky of her! Model Rachel McCord leaves VERY little to the imagination as she poses on Malibu beach in a barely-there black bikini
- White hot! Jennifer Lopez looks searching in tiny dress as she heads for romantic dinner with new beau Alex Rodriguez in Miami New reunion
- Angelina Jolie goes BRALESS as she meets Britain's Archbishop of Canterbury to discuss sexual violence and the refugee crisis as part of her humanitarian efforts
- Catch a 'haunted hangover' movie, wander the Malibu cliffs and sip flaming margaritas: How to do Los Angeles as a couple STUNNINGLY
- Kate ditches her St Patrick's Day hat to let hair down as she and Wills arrive in Paris for two-day Brexit charm offensive (but she's still wearing the same coat)
- Bangded blonde: Hillary and Huma spotted after day at the salon with Clinton debuting a new cuff and color while Abedin lugs around her boss' $2500 purse
- Ab-solutely amazing! Peta Murgatroyd flashes her svelte pooch bare belly as she heads to Dancing with the Stars practice with Bachelor hunk Nick Viall
- 'I've got to lose 10lbs in 11 days!': Mama June is pressured to shed even MORE weight as she's stuck at 180lbs in teaser from Not To Hot Mid mystery workout
- Heavily pregnant Jenna

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Here, Tom Leonard reveals the astonishing background to the case.

The new Gatsby

Even by the rags-to-riches-to-rags mythology of New York, Jeffrey Epstein's ascent and subsequent humbling has been breathtaking.

The son of a parks department employee, he was plucked from obscurity as a Manhattan private school maths teacher by a pupil's father who got him a job on Wall Street in 1976.

He rose rapidly at the investment bank Bear Stearns but left in 1981 to set up on his own, managing the fortunes of clients with $1billion or more.

Enigmatic and mysterious about his business activities, (some compare him to the fictional millionaire The Great Gatsby) he has only ever identified one of his clients - his mentor and main patron Leslie Wexner, whose business empire includes the upmarket Victoria's Secret lingerie chain.

How rich Epstein has become is a matter of conjecture but even his rich friends talk about his wealth with awe. His 52,000 sq ft, nine-floor, 40-room mansion on East 71st Street is supposedly the biggest private residence in Manhattan.

The pavement outside is heated from beneath to melt the snow.

He also owns a 7,500-acre ranch in New Mexico, a mansion in Palm Beach, a house in Westminster, an apartment in Avenue Foch, Paris, and Little St James, one of the US Virgin Islands.

His fleet of aircraft includes a Gulfstream jet, helicopter and a Boeing 727 on which he famously flew Bill Clinton and Kevin Spacey on an Aids mission to Africa.

He is a noted patron of science and – say awed observers – has a brilliantly acute mind. One says: 'You spend time in Jeffrey's company and you come away enriched, and not diminished.'

A new life: Virginia, now a mother-of-three, in Australia

Epstein's friends include not only Mr Clinton but Donald Trump, former Israeli prime minister Ehud Barak, top White House economist Larry Summers and a host of Nobel Prize winning scientists.

The Maxwell Connection

Despite his wealth, Epstein was for years a rare sighting on Manhattan's money-obsessed social scene. That ended in 1992 after he met Ghislaine Maxwell, glamorous and well-connected daughter of the disgraced British tycoon Robert Maxwell.

Some believe she was attracted by his resemblance to her similarly dominant and flamboyant father, but their romance reportedly ended because she wanted to marry and he wanted to see other women.

Bankrolled by Epstein, however, she established herself as a leading New York socialite and repaid the favour by putting Epstein in touch with her own well-heeled friends in Britain.

She introduced him to Prince Andrew in early 2000, quite probably during a holiday at the Mar-a-Lago Club in Palm Beach, owned by Donald Trump.

Epstein joined them on four other breaks over the year, including a beach holiday in Phuket, Thailand, another holiday in Florida and two occasions in Britain.

The first was a June engagement at Windsor Castle to celebrate the Queen's birthday, the second a weekend house party at Sandringham six months later which the prince arranged to celebrate Miss Maxwell's 39th birthday.

In between, she took him to an infamous 'hookers and pimps' party at a New York nightclub hosted by the former lingerie model Heidi Klum in a black latex S&M outfit.

Jameson puts HUGE baby bump on display in revealing jumpsuit during lunch date with fiance Lior Bitton

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EXCLUSIVE: William has new 'stomach-pat ritual' to help him cope when he is anxious reveals body language expert as she gives verdict on royal pair

How could William embarrass Kate so publicly? JAN MOIR says the Prince's ski trip exposes the Duchess to speculation about their marriage

"They were afraid I was going to be too fat": Plus-size model Ashley Graham details 'torment' of being dumped by ex-boyfriends because of her body shape

Miley Cyrus and fiance Liam Hemsworth show off their fit forms during hike in Los Angeles... days after her family denied that pair had married in secret

It's like looking in a mirror! Scarlett Johansson seems delighted with lifemask drawing of her gifted at South Korean premiere of Ghost in The Shell

"The honeymoon was a perfect opportunity to catch up on sleep": Princess Di's thoughts just days after marrying Prince Charles revealed in private letters

Emma Watson 'set to earn $20million from Beauty And The Beast' as co-star Dan Stevens reveals his daughter Willow, 7, helped design Belle's yellow dress

If it's good enough for Her Majesty! Bra expert and confidante to Britain's Queen Elizabeth reveals how you can achieve the PERFECT fit

Showing him what he's missing! Kourtney Kardashian shares view of her chest as she continues to spend time away from 'sex addict' Scott

Troubled teenager: Virginia on the billionaire's Zorro ranch in New Mexico in 2001

The prince was also at a Manhatten cocktail party thrown that year by Miss Maxwell which was filled with young Russian 'models' – some of the other guests were 'horrified', said an onlooker.

If the prince got the chance to party with a super-rich, never-married playboy who loved to surround himself with beautiful young women, the quid pro quo for Epstein was less obvious.

American friends noticed his delight in introducing 'Andrew' and waiting for them to make the royal connection. There have even been unsubstantiated rumours – most probably started by Epstein and on which Buckingham Palace would not comment – that he advised the Queen on her finances.

Murray Gell-Mann, a Nobel Prize winning physicist and recipient of Epstein largesse, said he was certainly given the impression by Epstein that she was a client.

Young girls in Palm Beach

Epstein's world began to implode in March 2005 when the mother of a 14-year-old girl went to police in Palm Beach accusing him of sexually assaulting her daughter.

The teenager told police she was taken to Epstein's mansion by an older girl and paid $300 after stripping to her knickers and massaging the man while he abused himself.

When police searched the mansion they found hidden cameras, photos of naked young girls on the walls and genitalia-shaped soap in the bathroom.

At least 40 girls aged 13 to 17 have come forward with similar stories, some saying Epstein sexually assaulted them during the massage.

According to Brad Edwards, a lawyer for some of the accusers, Epstein was molesting under-age girls every day he was in Palm Beach.

Police, who had wanted to pursue possible sex-trafficking charges, were furious and blamed Epstein's high-placed friends when he was allowed to strike a plea bargain under which he admitted two minor charges and was jailed for just 13 months.

'If it you or I did this, we'd be in prison for life,' said Mr Edwards. However, the girls have been allowed to take civil action and Epstein has so far made 40 hefty out-of-court settlements. Several girls said Ghislaine Maxwell had procured them.

Virginia's story

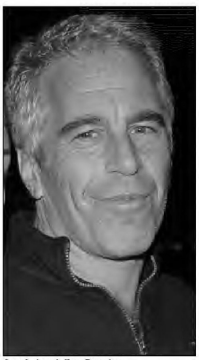
Of all the allegations made by anonymous girls against Epstein, one stood out as particularly earth-shattering.

Jane Doe 102, as she was known, claimed she had not only been abused by Epstein but had jetted around the world with him and was 'sexually exploited by [his] adult male peers, including royalty, politicians, academicians, businessmen and/or professional and personal acquaintances'.

She has now been identified as Virginia Roberts, a blonde, blue-eyed mother of three now living in Australia.

At the age of 15, she was working as a changing room assistant at the Mar-a-Lago club in Palm Beach.

She said she was approached by Ghislaine Maxwell, who offered her the chance to work for a wealthy 'gentleman' who needed a travelling masseuse.



Conviction: Jeffrey Epstein

They visited Epstein's pink mansion where, according to court papers, she was ordered to strip and straddle his naked body.

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Marilyn in color: Footage of Monroe shot by tourist between takes of Some Like It Hot shows how movie might have looked if it weren't black and white

'We eloped' Pregnant Amanda Seyfried's beau Thomas Sadoski reveals the couple have married in secret as she puts nude photo hoax behind her

Oh so chic: Bella Hadid puts a French twist on her look with leather beret and carries tote from her handbag collaboration She's always busy

He's met his match: Tom Cruise, 54, will go up against Superman star Henry Cavill, 33, in Mission: Impossible 6 The 33 year old Wolverine Star is skilled fighter

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Busty Jennifer Hudson battles bra wardrobe malfunction as she poses in tiny mini skirt outside radio studios She exposed more Hollywood than dreamed

Supermodel Ella Macpherson's personal trainer shares his tips on how you can lose 10 pounds in two weeks... and you don't have to give up wine!

Gear up & PLAY ON!

title nine

Christina Milian gives an eye-popping display by flaunting her ample assets in quirky ruffled dress as she attends nightclub opening in Los Angeles

'I am blessed to call you my son': Kris Jenner shares loving tribute to Rob Kardashian on his 30th birthday... but there's no word from Chyna

Orange is the new black: OWTS dancer Cheryl Burke goes underwear free in very sexy cut-out strapless dress at TAO launch in

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'My face was red with embarrassment but I felt under immense pressure to please them,' she told the Mail on Sunday.

'The whole time it was going on, they were promising me the world, that I'd travel with Jeffrey on his private jet and have a well-paid profession.'

Epstein paid her $200 for what he called the 'erotic message' and told her to return the next day. She spent the next four years with Epstein, for three of which she was under Florida's age of consent - 18.

'Basically, I was training to be a prostitute for him and his friends who shared his interest in young girls,' she says.

That stage of his alleged abuse started after two years when he asked her to fly to his Caribbean island and make a friend of his 'feel how you make me feel'.

She says she was given to men, aged from their 40s to their 60s, either on the island or on Epstein's New Mexico ranch.

Pampering a prince

Virginia says she met Prince Andrew three times. First, when she accompanied Epstein on a six-week trip to Europe and North Africa in 2001, they went to Ghislaine Maxwell's London house.

The following day, Andrew arrived and Miss Maxwell served tea and biscuits to the four of them.

Miss Maxwell invited the prince to guess Virginia's age and he correctly said '17', at which Miss Maxwell joked that Jeffrey would 'soon have to track her in'.

After dinner and a trip to Tramp nightclub where she danced with the prince, they returned to Miss Maxwell's house. They all went upstairs and Virginia asked Epstein to take a picture of her with Andrew to 'show my mom'.

She adds: 'Ghislaine and Jeffrey left us after that, and later Andrew left.' The following morning, Maxwell told her: 'You did well. He had fun.'

On the last leg of the trip, Epstein paid her $15,000 which she described as 'amazing money, more than I'd ever made on a trip with him before'.

She says she met Andrew a second time at Easter 2001, finding him sitting in a leather armchair at Epstein's Manhatton home.

Miss Maxwell had given him the prince a Spitting Image puppet of himself and another member of Epstein's entourage, Johanna Sjoberg, was sitting on his knee.

Miss Sjoberg, who was 21, herself described the incident to the Mail on Sunday three years ago. She said Miss Maxwell made Virginia sit on Andrew's other knee and then she 'put the puppet's hand on Virginia's breast, then Andrew put his hand on my breast'.

She added: 'It was a great joke. Everybody laughed.' The 'joke' earned Virginia $400 from Epstein.

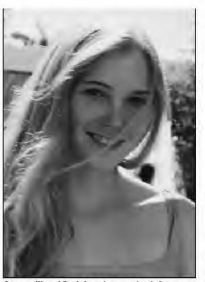
Her final encounter with the prince was on Epstein's Caribbean island, by which time she was 16.

There is no suggestion that there was ever any sexual contact between her and the prince or that Andrew know Epstein had paid her to have sexual contact with his friends.

By now, she says, Epstein was hinting she was 'too old' for him although he and Miss Maxwell once disgusted her by suggesting she had a child by him.

'They said I would have to sign a contract relinquishing rights to the child and consenting to Jeffrey having as many relationships as he liked,' she says. 'It was a smack in the face.'

For her 19th birthday, Epstein flew her to Thailand to take a massage course. She met an Australian martial arts expert there and married him ten days later.



Counselling: Virginia at her mother's home at Palm Beach in 1998

Epstein's plea bargain spared Virginia the ordeal of having to testify against him in court.

But she says she is 'appalled' by the light sentence he received. 'To me it's saying, "We are above the law". Jeffrey is a monster.'

An offender not a predator

Friends insist Epstein is 'looking for a new beginning' but it has not started with any show of remorse from the notoriously arrogant tycoon.

Stopped by a reporter in New York last week, he insisted: 'I'm not a sexual predator, I'm an offender... It's the difference between a murderer and a person who steals a bagel.'

Hollywood

Michelle steps back into the spotlight: Mrs Obama makes guest appearance on MasterChef Junior telling young chefs to cook healthier food

OMGigi! Supermodel Hadid displays her cleavage, taut abs and lean legs in a range of enticing ensembles as she poses for new fashion campaign

Harper Beckham is her mother's biggest fan as the five-year-old reveals that she is 'excited' to wear Victoria's new designs for Target

'He's my soulmate': Victoria Beckham praises her 'incredible husband' David as she reveals she's inspired by his kindness every day

'I'm not sure he'll be changing diapers': Cindy Crawford's husband Rande Gerber weighs in on the type of dad his pal George Clooney, 55, will be

Fake locksmith secretly filmed Brigitte Bardot before trying to sell footage of intimate moments after tricking his way into her St Tropez home

Hey girl Dazzling Eva Mendes returns to the spotlight after spending six months with her children while Ryan Gosling hit the La La Land promo trail

EXCLUSIVE: Meet Dusinaria Poot, dusky night club promoter who hand-picked sexy models for Justin Bieber's Aussie boat party

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Gwyneth Paltrow and Chris Martin FINALLY sell their NYC penthouse after $8million cut and a year on the market Coldplay lovers have a deal for former friends exes

Tara Reid looks glam in sequin blazer as she oozes up to mystery man at opening of TAO venue in Hollywood The 41-year-old actress brought some star

Ryan Lochte packs on the PDA with his pregnant fiancée Kayla Rae Reid as couple enjoy date night at LA bash Disgraced swimmer

'It's about 25 percent of their income': Kim, Kourtney, and Khloe Kardashian make SIX FIGURES for a sponsored post on social media

This particular bagel thief has been put in the highest re-offending risk category in the US sex offenders' register.

But while Leslie Wexner, his billionaire client, has dispensed with his services, other less wealthy friends are more than happy still to fraternise with the convicted paedophile.

They include Prince Andrew, who spent five days staying at Epstein's Manhattan mansion in December.

He was guest of honour at a party thrown by Epstein and attended by Woody Allen, CBS News presenter Katie Couric and several other broadcasters, all of them light-heartedly pestering for invitations to Prince William's wedding.

Organiser: Ghislaine Maxwell looks on as Andrew put his arm around Virginia. Robert Maxwell's daughter invited her to work as Epstein's personal masseuse soon after her 15th birthday

Rosa Monckton, the jeweller and former confidante of Diana, Princess of Wales, has been a friend of Epstein since they met at a dinner party in London in the 1980s.

She said she was not surprised that Prince Andrew was still willing to associate with him.

'It shows he's a good friend,' she says. 'Jeffrey is an extraordinarily loyal friend, and if somebody's loyal to you, you're loyal back. Whatever Jeffrey did, he's been punished for.'

As for Ghislaine Maxwell, she is still close to Epstein although, according to a member of staff at her New York home yesterday, she had conveniently 'gone away until next week'.

Epstein himself is picking up the reins of a business without its main client (Mr Wexner). Friends confide that 'it is a difficult time for him'.

Brad Edwards, the lawyer representing some of his accusers in Florida, is sceptical over whether Epstein will be able to get over his hankering for the sexual ministrations of poor, easily-exploited young girls – whatever his friends say. 'To me, it's a tough habit to break,' he says.

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She looked stunning

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Justin Bieber can't hide his breakouts as he eats BBQ chicken after McDonald's run the day before... while he gets close to another sexy model

Charlotte McKinney brings bombshell look in black mini dress at Hollywood development grand opening party
The 22 year old actress attended

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90210 star AnnaLynne McCord looks stunning in a glittering semi-sheer dress and thigh high boots as she parties at beauty bash in LA

Penelope Cruz looks chic in pinstripe suit as she arrives hand in hand with husband Javier Bardem to celebrate lookalike sister Monica's 40th birthday

The Lord of fine dining! Scott Disick bonds with his kids and North West as he takes them to upscale sushi lunch at Nobu
Quality time with his kids

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Is quite the renovation queen

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Tiny Dancer! Kim and Janye's kid North West looks the picture of cuteness as she pirouettes along during fun-filled family outing in Malibu

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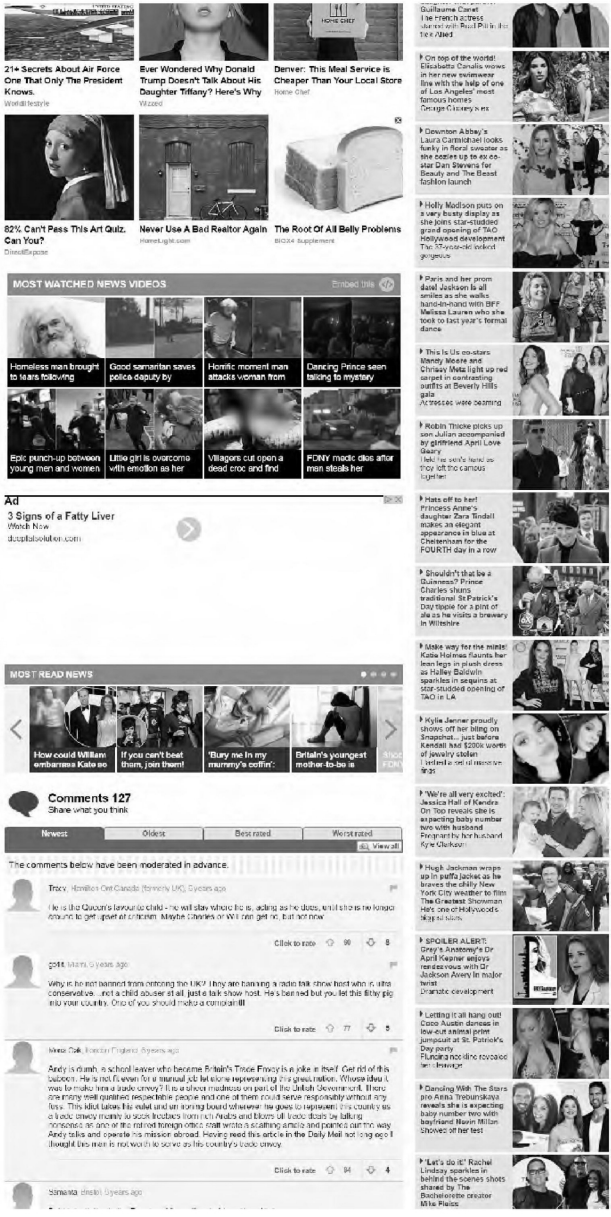
Baby Joy! Marion Cotillard, 41, welcomes a daughter with partner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He is the Queen's favourite child - he will stay whoever he is, acting as he does, until she is no longer around to get upset at criticism. Maybe Charles or Will can get rid, but not now
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Andy is dumb, a school leaver who became Britain's Trade Envoy is a joke in itself. Get rid of this buffoon. He is not fit even for a manual job let alone representing this great nation. Whose idea it was to make him a trade envoy? It is a sheer madness on part of the British Government. There are many well qualified respectable people and one of them could serve responsibly without any fuss. This idiot takes his duties and an working board wherever he goes to represent this country as a trade envoy mainly to seek freebies from rich Arabs and filters all trade deals by talking nonsense as one of the retired foreign office staff wrote a scathing article and pointed out the way Andy talks and operate his mission abroad. Having read this article in the Daily Mail not long ago I thought this man is not worth to serve as his country's trade envoy.
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Holly Madison puts on a very busty display as she joins star-studded grand opening of TAO Hollywood development The 35-year-old looked gorgeous
Paris and her prom date! Jackson Ia all smiles as she walks hand-in-hand with BFF Melissa Lauren who she took to last year's formal dance
This Is Us co-stars Mandy Moore and Chrissy Metz light up red carpet in contrasting outfits at Beverly Hills gala Actresses were beaming
Robin Thicke picks up son Julian accompanied by girlfriend April Love Geary Had his son's hand as they left the famous together
Hats off to her! Princess Anne's daughter Zara Tindall makes an elegant appearance in blue at Cheltenham for the FOURTH day in a row
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Make way for the minis! Katie Holmes flaunts her lean legs in plush dress as Hailey Baldwin sparkles in sequins at star-studded opening of TAO in LA
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Hugh Jackman wraps up in puffy jacket as he braves the chilly New York City weather to film The Greatest Showman He's one of Hollywood's biggest stars
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Dancing With The Stars pro Anna Trebunskaya reveals she is expecting baby number two with boyfriend Nevin Millan Shoves off her feet
'Let's do it!' Rachel Lindsay sparkles in behind the scenes shots shared by The Bachelorette creator Mike Fleiss

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Dina Khayyam (Walkerg) UK 6 years ago

Why doesn't he go back to dear old Sandra? she might suck his toes for him, and she'll get a fright well at "you know what".

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North, East Sussex, 6 years ago

And of course he'd no idea Fergie was offering his services for money.

Click to rate 79 4

DB1, Nottingham ENGLAND, 6 years ago

There is no suggestion that there was ever any sexual contact between her and the prince or that And we know Fergie had paid her to have sexual contact with his friends. That being the case then this is really not a journalistic story is it? Or is guilt by association now a crime?

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David, Solihull, 6 years ago

British businesses will probably fall apart without the leadership that this wonderful man provides. He truly is a pillar among men.

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NKC, Maidstone, 6 years ago

All I'd she know what she was doing - basically a prostitute and she is still living to get money and sell her story. It takes two to tango. She seems to have no shame.

Click to rate 11 32

Alison, North Wales, 6 years ago

As a trained, qualified and insured professional masseur, it makes me very angry to hear what these girls are described as "massage"! None of them knows the first thing about massage, they were prostitutes who touched men with no idea or intention other than to sexually excite. No wonder we have to battle such prejudice when newspapers still use the term massage to describe their activities.

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The royal treatment! Prince Albert of Monaco's daughter Jazmin Grace Grimaldi packs on PDA with boyfriend Ian Mellencamp in LA

Fabulous at 50! Halle Berry shows fit physique in tank-top and leggings while picking up skin care supplies. Oscar-winning actress looking fantastic

All business! Jessica Biel leaves her kid-friendly Hollywood eatery in chic ensemble of black sweater and white pencil skirt. At Au Fudge restaurant

An eight-car garage, infinity pool, FIVE bedrooms and a very SEXY ensuite bathroom: Inside the mansion Justin Bieber is renting during his Sydney stay

More attraction: Vanessa Hudgens shows off new extensions during horseback riding lessons in LA. The kept them in check

Making friends? Justin Bieber enjoys a pleasant exchange with an Iggy Azalea lookalike fan dressed in a surfed crop top and black bra in Sydney

Jesy Nelson fiercely denies feud with Little Mix bandmate Perrie Edwards... as it's claimed she ditched girls' night for date with new love Chris Clark

It looks like Justin has a thing for yummy mommies! Meet model Sarah Fitzgerald... the married mom Bieber partied with during cruise

She's not meant jeans!

EXHIBIT L

Jeffrey Epstein 'sex slave' Virginia Roberts was a 'money-hungry sex kitten', ex friends claim

www.dailymail.co.uk/news/article-2974613/Jeffrey-Epstein-sex-slave-money-hungry-sex-kitten-enjoyed-role-travelling-masseuse-former-friends-claim.html

Jeffrey Epstein 'sex slave' lived a lavish lifestyle and enjoyed her role as his 'travelling masseuse', former friends claim

- **Virginia Roberts claims she was recruited to Epstein's harem in 1999**
- **Named Prince Andrew and Alan Dershowitz as men she had to 'service'**
- **Her friends say there was no indication she was being held captive**
- **Asked other women if they knew anyone 'slutty' to bring to Epstein**
- **Would allegedly use cash she gained from sex to live a luxury lifestyle**

By Wills Robinson For Dailymail.com

Published: 12:49 EDT, 1 March 2015 | Updated: 07:09 EDT, 2 March 2015

Shocking: Virginia Roberts' friends claim she was a money-hungry sex kitten' who enjoyed her lavish lifestyle

The woman who has accused Jeffery Epstein of keeping her as a sex slave was actually a money-hungry sex kitten' who enjoyed her lavish lifestyle, former friends have claimed.

Virginia Roberts is currently in the midst of a lawsuit claiming she was recruited to join Epstein's harem of underage women in 1999, naming Prince Andrew and attorney Alan Dershowitz as two of the men she was made to 'service'.

But those who used to be close to the 31-year-old say she relished her role as his 'travelling masseuse' and never acted like she was being held captive.

Philip Guderyon, who used to date Roberts and would drive her to Epstein's Pal Beach, Florida, mansion told the New York Daily News: 'She was like the head b***h. She'd have like nine or 10 girls she used to bring to him.

'She never looked like she was being held captive,' he added. 'She and the other girls would walk out of there smiling, with their little bathing suits on, like they had just come from the beach.

'She'd have like $4,000. And then I'd take them all to the mall and they'd get their nails done.'

He also said while making thousands of dollars from the relationship, she would buy fancy clothes and drive around in Epstein's Mercedes.

Crystal Figueroa, whose brother dated Roberts in the early 2000s, told the Daily News Roberts would ask if she knew anyone 'slutty' so they could be sent to Epstein.

In 2001 she was sharing a Palm Beach apartment with Anthony Valladares. He told the Daily News that she bragged about going to the 'millionaire's house' for a day or two, before returning with cash.

He did say that she tried to get out of the sex business, but was dragged back in.

Last month it was revealed Roberts accused two male acquaintances she was raped, bringing her credibility into

question.

Roberts' lawyers says the latest allegations do not contend the fact she was used for underage sex.

Attorney Sigrid McCawleysaid : 'To say that our client acquiesced in this abuse, or that the abuse was OK because she was paid for it — leaves out the fact that this is why we have laws in the United States to protect minor children who are groomed and sexually trafficked by adults.'

Epstein served 13 months in a Florida prison after pleading guilty in 2008 to soliciting a minor for prostitution.

Allegations: The 31-year-old is currently in the midst of a lawsuit claiming she was recruited to join Epstein's harem of underage women in 1999, naming Prince Andrew and attorney Alan Dershowitz as two of the men she was made to 'service'

The scandal resurfaced in January when Roberts named Prince Andrew in a lawsuit, accusing him of using her for underage sex.

According to court records connected with Roberts' current lawsuit, she maintains that she was recruited to join Epstein's harem in 1999 by his friend, the socialite Ghislaine Maxwell.

She says during the three years she worked for Epstein, she was made to entertain his friends and named Prince Andrew and Dershowitz as two men she had sex with.

Both men have denied having sex with Roberts, and Dershowitz is trying to get his name removed from the suit, claiming Roberts made the entire story up.

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REDACTED
EXHIBIT M

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EXHIBIT N

REDACTED
EXHIBIT O

REDACTED
EXHIBIT P

REDACTED
EXHIBIT Q

EXHIBIT R

FOR IMMEDIATE RELEASE **Contact:** Richard A. Simpson, RSimpson@wileyrein.com
April 8, 2016

Lawyers Acknowledge Mistake In Filing Sexual Misconduct Charges Against Professor Dershowitz

Professor Alan M. Dershowitz released the following statement regarding resolution of the case styled *Bradley Edwards, et al. v. Alan M. Dershowitz*, Case No. CACE 15-000072 (Cir. Ct., Broward Cnty., Fla.).

STATEMENT OF ALAN M. DERSHOWITZ

I am pleased that the litigation has concluded and I am gratified by the Joint Statement issued today by Jeffrey E. Streitfeld on behalf of the parties, in which "Edwards and Cassell acknowledge that it was a mistake to have filed sexual misconduct accusations against Dershowitz and the sexual misconduct accusations made in all public filings (including all exhibits) are hereby withdrawn." Mr. Streitfeld's announcement and the Joint Statement are copied below.

ANNOUNCEMENT BY JEFFREY E. STREITFELD, FLORIDA SUPREME COURT CERTIFIED CIRCUIT CIVIL MEDIATOR (Streitfeldlaw.com)

It is my pleasure to report that Bradley J. Edwards, Paul G. Cassell, and Alan M. Dershowitz have resolved their disputes and have agreed to settle the claims raised in an action pending in the Broward County, Florida Circuit Court. Since being appointed by Circuit Court Judge Thomas Lynch IV last fall, it has been a privilege to act as the mediator and assist the parties and their counsel toward this agreed resolution. I want to extend my appreciation for the professionalism exhibited by the parties and their counsel with whom I worked directly: Jack Scarola, Rick Simpson, Tom Scott, and Ken Sweder. As part of their agreement, the parties have issued the attached Joint Statement.

JOINT STATEMENT OF BRAD EDWARDS, PAUL CASSELL AND ALAN DERSHOWITZ REGARDING SETTLEMENT

Brad Edwards, Paul Cassell and Alan Dershowitz have today settled their pending defamation claims in which Edwards and Cassell sued Dershowitz and Dershowitz counterclaimed against Edwards and Cassell. The case was about Dershowitz's public claims that Edwards and Cassell, as the attorneys for Virginia Roberts, had failed to perform the necessary due diligence before filing the allegations of their client, not whether the acts of alleged misconduct in fact occurred. Edwards and Cassell vigorously denied the contention that they had acted improperly and asserted that it defamed them. Dershowitz countersued Edwards and Cassell, alleging they had falsely accused him of sexual contact with Roberts—a claim he vigorously denied and that Dershowitz asserted defamed him. Edwards and Cassell maintain that they filed their client's allegations in good faith and performed the necessary due diligence to do so, and have produced documents detailing those efforts. Dershowitz completely denies any such misconduct, while not disputing Roberts's statements that the underlying alleged misconduct may have occurred with someone else. Dershowitz has produced travel and other records for the relevant times which he relies on to establish that he could not have been present when the alleged

misconduct occurred. He has also produced other evidence that he relies upon to refute the credibility of the allegations against him.

The parties believe it is time to take advantage of the new information that has come to light on both sides during the litigation and put these matters behind them.

Given the events that have transpired since the filing of the documents in the federal court and in this action in which Dershowitz was accused of sexual misconduct, including the court order striking the allegations in the federal court filings, and the records and other documents produced by the parties, Edwards and Cassell acknowledge that it was a mistake to have filed sexual misconduct accusations against Dershowitz; and the sexual misconduct accusations made in all public filings (including all exhibits) are hereby withdrawn. Dershowitz also withdraws his accusations that Edwards and Cassell acted unethically.

Neither Edwards, Cassell, nor Dershowitz have any intention of repeating the allegations against one another.

# # # #

Editor's note: Wiley Rein LLP represents Alan M. Dershowitz in this matter.

EXHIBIT S

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF FLORIDA

CASE NO.:08-CV-80736-KAM

JANE DOE 1 and JANE DOE 2,

Petitioners,

vs.

UNITED STATES OF AMERICA,

Respondent.

_____/

ORDER DENYING PETITIONERS' MOTION TO JOIN UNDER RULE 21 AND MOTION TO AMEND UNDER RULE 15

This cause is before the Court on Jane Doe 3 and Jane Doe 4's Corrected Motion Pursuant to Rule 21 for Joinder in Action ("Rule 21 Motion") (DE 280), and Jane Doe 1 and Jane Doe 2's Protective Motion Pursuant to Rule 15 to Amend Their Pleadings to Conform to Existing Evidence and to Add Jane Doe 3 and Jane Doe 4 as Petitioners ("Rule 15 Motion") (DE 311). Both motions are ripe for review. For the following reasons, the Court concludes that they should be denied.

I. Background

This is an action by two unnamed petitioners, Jane Doe 1 and Jane Doe 2, seeking to prosecute a claim under the Crime Victims' Rights Act (CVRA), 18 U.S.C. § 3771. (DE 1). Generally, they allege that the respondent Government violated their rights under the CVRA by failing to consult with them before negotiating a non-prosecution agreement with Jeffrey Epstein, who subjected them to various sexual crimes while they were minors. (Id.). Petitioners initiated this action in July 2008. (Id.).

On December 30, 2014, two other unnamed victims, Jane Doe 3 and Jane Doe 4, moved to join as petitioners in this action pursuant to Federal Rule of Civil Procedure 21. (DE 280). Petitioners (Jane Doe 1 and Jane Doe 2) support the Rule 21 Motion. (Id. at 11). Jane Doe 3 and Jane Doe 4 argue that they "have suffered the same violations of their rights under the [CVRA] as the" Petitioners, and they "desire to join in this action to vindicate their rights as well." (Id. at 1). The Government vehemently opposes joinder under Rule 21. (DE 290). The Government argues that Rule 15 is the proper procedural device for adding parties to an action, not Rule 21. (Id. at 1).

"[O]ut of an abundance of caution," Petitioners filed a motion to amend their petition under Rule 15, conforming the petition to the evidence and adding Jane Doe 3 and Jane Doe 4 as petitioners. (DE 311 at 2). The Government opposes the Rule 15 Motion as well. (DE 314). Among other things, the Government argues that amending the petition to include Jane Doe 3 and Jane Doe 4 should be denied because of their undue delay in seeking to join the proceedings, and the undue prejudice that amendment will cause. (Id.).

After considering the parties' submissions and the proposed amended petition, the Court finds that justice does not require amendment in this instance and exercises its discretion to deny the amendment.

II. Discussion

"The decision whether to grant leave to amend a complaint is within the sole discretion of the district court." Laurie v. Ala. Ct. Crim. Apps., 256 F.3d 1266, 1274 (11th Cir. 2001). "The court should freely give leave when justice so requires." Fed. R. Civ. P. 15(a)(2). Justice does not require amendment in several instances, "includ[ing] undue delay, bad faith, dilatory motive

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on the part of the movant, . . . undue prejudice to the opposing party by virtue of allowance of the amendment, [and] futility of amendment.'" Laurie, 256 F.3d at 1274 (quoting Foman v. Davis, 371 U.S. 178, 182 (1962)). In addition to considering the effect of amendment on the parties, the court must consider "the importance of the amendment on the proper determination of the merits of a dispute." 6 Wright & Miller, Fed. Prac. & Fed. P. § 1488, p. 814 (3d ed. 2010). Justice does not require amendment where the addition of parties with duplicative claims will not materially advance the resolution of the litigation on the merits. See Herring v. Delta Air Lines, Inc., 894 F.2d 1020, 1024 (9th Cir. 1989).

A. Rule 21 Motion

Jane Doe 3 and Jane Doe 4's first attempt to join in this proceeding was brought under Rule 21. (DE 280). "If parties seek to add a party under Rule 21, courts generally use the standard of Rule 15, governing amendments to pleadings, to determine whether to allow the addition." 12 Wright & Miller, Fed. Prac. & Fed. P., p. 432 (3d ed. 2013); see also Galustian v. Peter, 591 F.3d 724, 729-30 (4th Cir. 2010) (collecting cases and noting that Rule 15(a) applies to amendments seeking to add parties); Frank v. U.S. West, Inc., 3 F.3d 1357, 1365 (10th Cir. 1993) ("A motion to add a party is governed by Fed. R. Civ. P. 15(a) . . . .").

Rule 21, "Misjoinder and Non-joinder of Parties," provides the court with a tool for correcting the "misjoinder" of parties that would otherwise result in dismissal. Fed. R. Civ. P. 21. Insofar as Rule 21 "relates to the addition of parties, it is intended to permit the bringing in of a person, who through inadvertence, mistake or for some other reason, had not been made a party and whose presence as a party is later found necessary or desirable." United States v. Com. Bank of N. Am., 31 F.R.D. 133, 135 (S.D.N.Y. 1962) (internal quotation marks omitted).

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In their Rule 21 Motion, Jane Doe 3 and Jane Doe 4 do not claim that they were omitted from this proceeding due to any "inadvertence" or "mistake" by Petitioners; rather, they seek to join this proceeding as parties that could have been permissively joined in the original petition under Rule 20 ("Permissive Joinder of Parties"). As courts generally use the standards of Rule 15 to evaluate such circumstances, the Court will consider the joinder issue as presented in the Rule 15 Motion.[1] The Court will consider the arguments presented in the Rule 21 Motion as if they are set forth in the Rule 15 Motion as well. Because the arguments are presented in the Rule 15 Motion (and because the Court is denying the Rule 15 Motion on its merits, as discussed below), the Rule 21 Motion will be denied.

The Court also concludes that portions of the Rule 21 Motion—and related filings—should be stricken from the record. Pending for this Court's consideration is a Motion for Limited Intervention filed by Alan M. Dershowitz, who seeks to intervene to "strike the outrageous and impertinent allegations made against him and [to] request[] a show cause order to the attorneys that have made them." (DE 282 at 1). The Court has considered Mr. Dershowitz's arguments, but it finds that his intervention is unnecessary as Federal Rule of Civil Procedure 12(f) empowers the Court "on its own" to "strike from a pleading an insufficient defense or any redundant, immaterial, impertinent, or scandalous matter." Fed. R. Civ. P. 12(f).

Petitioners' Rule 21 Motion consists of relatively little argumentation regarding why the Court should permit them to join in this action: they argue that (1) they were sexually abused by

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[1] The Court notes that, regardless of which motion it considers, the same standard governs the addition of parties under Rule 21 and Rule 15. See Goston v. Potter, No. 08-cv-478 FJS ATB, 2010 WL 4774238, at *5 (N.D.N.Y. 2010) (citing Bridgeport Music, Inc. v. Universal Music Grp., Inc., 248 F.R.D. 408, 412 (S.D.N.Y. 2008)).

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Jeffrey Epstein, and (2) the Government violated their CVRA rights by concealing the non-prosecution agreement with them. (DE 280 at 3; see id. at 7-8). However, the bulk of the Rule 21 Motion consists of copious factual details that Jane Doe 3 and Jane Doe 4 "would prove" "[i]f allowed to join this action." (Id. at 3, 7). Specifically, Jane Doe 3 proffers that she could prove the circumstances under which a non-party introduced her to Mr. Epstein, and how Mr. Epstein sexually trafficked her to several high-profile non-party individuals, "including numerous prominent American politicians, powerful business executives, foreign presidents, a well-known Prime Minister, and other world leaders." (Id. at 3-6). She names several individuals, and she offers details about the type of sex acts performed and where they took place. (See id. at 5).[2]

At this juncture in the proceedings, these lurid details are unnecessary to the determination of whether Jane Doe 3 and Jane Doe 4 should be permitted to join Petitioners' claim that the Government violated their rights under the CVRA. The factual details regarding with whom and where the Jane Does engaged in sexual activities are immaterial and impertinent to this central claim (i.e., that they were known victims of Mr. Epstein and the Government owed them CVRA duties), especially considering that these details involve non-parties who are not related to the respondent Government. These unnecessary details shall be stricken.

The original Rule 21 Motion (DE 279) shall be stricken in its entirety, as it is wholly superseded by the "corrected" version of the Rule 21 Motion (DE 280). From the corrected Rule 21 Motion, the Court shall strike all factual details regarding Jane Doe 3 between the following sentences: "The Government then concealed from Jane Doe #3 the existence of its NPA from

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[2] Jane Doe 4's proffer is limited to sexual acts between Mr. Epstein and herself. (See DE 280 at 7-8).

Jane Doe #3, in violation of her rights under the CVRA" (id. at 3); and "The Government was well aware of Jane Doe #3 when it was negotiating the NPA, as it listed her as a victim in the attachment to the NPA" (id. at 6). As none of Jane Doe 4's factual details relate to non-parties, the Court finds it unnecessary to strike the portion of the Rule 21 Motion related to her circumstances. Regarding the Declaration in support of Petitioners' response to Mr. Dershowitz's motion to intervene (DE 291-1), the Court shall strike paragraphs 4, 5, 7, 11, 13, 15, 19 through 53, and 59, as they contain impertinent details regarding non-parties. Regarding the Declaration of Jane Doe 3 in support of the Rule 21 Motion (DE 310-1), the Court shall strike paragraphs 7 through 12, 16, 39, and 49, as they contain impertinent details regarding non-parties. Jane Doe 3 is free to reassert these factual details through proper evidentiary proof, should Petitioners demonstrate a good faith basis for believing that such details are pertinent to a matter presented for the Court's consideration.

As mentioned, Mr. Dershowitz moves to intervene "for the limited purposes of moving to strike the outrageous and impertinent allegations made against him and requesting a show cause order to the attorneys that have made them." (DE 282 at 1). As the Court has taken it upon itself to strike the impertinent factual details from the Rule 21 Motion and related filings, the Court concludes that Mr. Derschowitz's intervention in this case is unnecessary. Accordingly, his motion to intervene will be denied as moot.[3] Regarding whether a show cause order should

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[3] This also moots Mr. Dershowitz's Motion for Leave to File Supplemental Reply in Support of Motion for Limited Intervention. (DE 317). Denying Mr. Dershowitz's motion to intervene also renders moot Petitioners' motion (DE 292) to file a sealed document supporting its response to Mr. Dershowitz's motion. It will accordingly be denied as moot, and DE 293 (the sealed response) will be stricken from the record.

issue, the Court finds that its action of striking the lurid details from Petitioners' submissions is sanction enough. However, the Court cautions that all counsel are subject to Rule 11's mandate that all submissions be presented for a proper purpose and factual contentions have evidentiary support, Fed. R. Civ. P. 11(b)(1) and (3), and that the Court may, on its own, strike from any pleading "any redundant, immaterial, impertinent, or scandalous matter," Fed. R. Civ. P. 12(f).

B. Rule 15 Motion

Between their two motions (the Rule 21 Motion and Rule 15 Motion), Jane Doe 3 and Jane Doe 4 assert that "they desire to join in this action to vindicate their rights [under the CVRA] as well." (DE 280 at 1). Although Petitioners already seek the invalidation of Mr. Epstein's non-prosecution agreement on behalf of all "other similarly-situated victims" (DE 189 at 1; DE 311 at 2, 12, 15, 18-19), Jane Doe 3 and Jane Doe 4 argue that they should be fellow travelers in this pursuit, lest they "be forced to file a separate suit raising their claims" resulting in "duplicative litigation" (DE 280 at 11). The Court finds that justice does not require adding new parties this late in the proceedings who will raise claims that are admittedly "duplicative" of the claims already presented by Petitioners.

The Does' submissions demonstrate that it is entirely unnecessary for Jane Doe 3 and Jane Doe 4 to proceed as parties in this action, rather than as fact witnesses available to offer relevant, admissible, and non-cumulative testimony. (See, e.g., DE 280 at 2 (Jane Doe 3 and Jane Doe 4 "are in many respects similarly situated to the current victims"), 9 ("The new victims will establish at trial that the Government violated their CVRA rights in the same way as it violated the rights of the other victims."), 10 (Jane Doe 3 and Jane Doe 4 "will simply join in motions that the current victims were going to file in any event."), 11 (litigating Jane Doe 3 and

Jane Doe 4's claims would be "duplicative"); DE 298 at 1 n.1 ("As promised . . . Jane Doe No. 3 and Jane Doe No. 4 do not seek to expand the number of pleadings filed in this case. If allowed to join this action, they would simply support the pleadings already being filed by Jane Doe No. 1 and Jane Doe No. 2."); DE 311 at 5 n.3 ("[A]ll four victims (represented by the same legal counsel) intend to coordinate efforts and avoid duplicative pleadings."), 15 (Jane Doe 3 and Jane Doe 4 "challenge the same secret agreement—i.e., the NPA that the Government executed with Epstein and then concealed from the victims. This is made clear by the proposed amendment itself, in which all four victims simply allege the same general facts.")). As the Does argue at length in their Rule 15 Motion, Jane Doe 1's original petition "specifically allege[s] that the Government was violating not only her rights but the rights of other similarly-situated victims." (DE 311 at 2). The Court fails to see why the addition of "other similarly-situated victims" is now necessary to "vindicate their rights as well." (DE 280 at 1).

Of course, Jane Doe 3 and Jane Doe 4 can participate in this litigated effort to vindicate the rights of similarly situated victims—there is no requirement that the evidentiary proof submitted in this case come only from the named parties. Petitioners point out as much, noting that, regardless of whether this Court grants the Rule 15 Motion, "they will call Jane Doe No. 3 as a witness at any trial." (DE 311 at 17 n.7). The necessary "participation" of Jane Doe 3 and Jane Doe 4 in this case can be satisfied by offering their properly supported—and relevant, admissible, and non-cumulative—testimony as needed, whether through testimony at trial (see DE 280 at 9) or affidavits submitted to support the relevancy of discovery requests[4] (see

[4] The non-party Jane Does clearly understand how to submit affidavits. (See DEs 291-1, 310-1).

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id. at 10). Petitioners do not contend that Jane Doe 3 and Jane Doe 4's "participation in this case" can only be achieved by listing them as parties.

As it stands under the original petition, the merits of this case will be decided based on a determination of whether the Government violated the rights of Jane Doe 1, Jane Doe 2, and all "other similarly situated victims" under the CVRA. Jane Doe 3 and Jane Doe 4 may offer relevant, admissible, and non-cumulative evidence that advances that determination, but their participation as listed parties is not necessary in that regard. See Herring, 894 F.2d at 1024 (District court did not abuse its discretion by denying amendment where "addition of more plaintiffs . . . would not have affected the issues underlying the grant of summary judgment."); cf. Arthur v. Stern, 2008 WL 2620116, at *7 (S.D. Tex. 2008) (Under Rule 15, "courts have held that leave to amend to assert a claim already at issue in [another lawsuit] should not be granted if the same parties are involved, the same substantive claim is raised, and the same relief is sought.").[5] And, as to Jane Doe 4 at least, adding her as a party raises unnecessary questions about whether she is a proper party to this action.[6]

Petitioners also admit that amending the petition to conform to the evidence—by including references to the non-prosecution agreement itself—is "unnecessary" as the "existing petition is broad enough to cover the developing evidence in this case." (DE 311). The Court

---

[5] The Court expresses no opinion at this time whether any of the attestations made by Jane Doe 3 and Jane Doe 4 in support of their motion will be relevant, admissible, and non-cumulative.

[6] The Government contends that Jane Doe 4 is not a true "victim" in this case because she was not known at the time the Government negotiated the non-prosecution agreement, and accordingly she was not entitled to notification rights under the CVRA. (See DE 290 at 10). Any "duplicative" litigation filed by Jane Doe 4 would necessarily raise the issue of whether she has standing under the CVRA under these circumstances.

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agrees, and it concludes that justice does not require amending the petition this late in the proceedings.

III. Conclusion

Accordingly, it is hereby **ORDERED AND ADJUDGED** as follows: the Rule 21 Motion (DE 280) is **DENIED**; the Rule 15 Motion (DE 311) is **DENIED**; Intervenor Dershowitz's Motion for Limited Intervention (DE 282) and Motion for Leave to File Supplemental Reply in Support of Motion for Limited Intervention (DE 317) are **DENIED AS MOOT**; Petitioners' Motion to Seal (DE 292) is **DENIED AS MOOT**; the following materials are hereby **STRICKEN** from the record:

- DE 279, in its entirety.
- DE 280, all sentences between the following sentences: "The Government then concealed from Jane Doe #3 the existence of its NPA from Jane Doe #3, in violation of her rights under the CVRA" (DE 280 at 3); and "The Government was well aware of Jane Doe #3 when it was negotiating the NPA, as it listed her as a victim in the attachment to the NPA" (DE 280 at 6).
- DE 291-1, paragraphs 4, 5, 7, 11, 13, 15, 19 through 53, and 59.
- DE 310-1, paragraphs 7 through 12, 16, 39, and 49.
- DE 293, in its entirety.

DONE AND ORDERED in chambers at West Palm Beach, Palm Beach County, Florida, this 6th day of April, 2015.

KENNETH A. MARRA
United States District Judge

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From: Richard Kahn[redacted]
Sent: 4/4/2017 5:28:21 PM
To: jeffrey E. [jeevacation@gmail.com]
Subject: Fwd: White House exploring VAT (Washington Post)
Attachments: image002jpg01D2AD4706F2BBA0.jpg; image001jpg01D2AD460BC6CE60.jpg

Importance: High

Richard Kahn
HBRK Associates Inc.
575 Lexington Avenue 4th Floor
New York, NY 10022
tel [redacted]
fax
cell

Begin forwarded message:

From: "Ens, Amanda" <[redacted]>
Subject: White House exploring VAT (Washington Post)
Date: April 4, 2017 at 1:26:22 PM EDT
To: "Rich Kahn"<[redacted]>
Reply-To: "Ens, Amanda" <[redacted]>

David Woo just sent this – please let me know if you'd like an update on his Washington/market views

More sign that VAT is making its way into the discussion....
As you all know, I have been arguing that VAT make tremendous economic sense
A VAT has all the virtues of a BAT without any of its drawbacks
The fact that this is being discussed makes me think that we are getting to a more serious stage of the negotiation over tax reform
This news is bullish for Trump trades, at least for the medium-term

White House explores two new tax ideas — a value-added tax and carbon tax — as leading proposal to raise revenue falters

Washington Post
April 4

By Damian Paletta and Max Ehrenfreund

President Trump's administration is exploring the creation of two controversial new taxes — a value-added tax and a carbon tax — as part of a broad overhaul of the tax code, according to an administration official and one other person briefed on the process.

The value-added tax, which is popular in many other countries, would serve as a kind of national sales tax, one that consumers would pay when they make purchases and that businesses would pay for supplies, services and raw materials. A carbon tax would target the emissions of carbon dioxide and other greenhouses gases in the burning of gasoline, coal and other fossil fuels.

The study of the new options — which would represent major changes to American economic policy — comes as the administration looks to tax reform as its next major battleground for implementing its agenda. Trump wants to cut taxes sharply, but his advisers are looking for ways to raise revenue so as not to create a giant hole in the deficit.

Administration officials stressed that no final decision has been made and they are reviewing different alternatives. Two officials and a third person confirmed the consideration of the value-added tax, while one official and the third person confirmed the consideration of the carbon tax.

The search for new options reflects a recognition of the political challenges facing a proposal known as a border-adjustment tax that the White House and some Republicans had begun to rally around. The proposal, effectively a tax on imports, would not only raise needed revenue but also serve to fulfill Trump's pledge to protect American companies from unfair export competition.

The tax would create incentives for companies to manufacture and produce goods domestically. But the proposal is unpopular with many other Republicans, who have said it would raise costs for consumers on things such as automobiles, electronics and clothing.

A value-added tax and a carbon tax have long been favored tools among economists, including some on the right, to raise revenue in a way that supports economic growth. But the prospect of any new taxes has long drawn skepticism from Republicans.

Amanda Ens
Director
Bank of America Merrill Lynch
Merrill Lynch, Pierce, Fenner & Smith Incorporated
One Bryant Park, 5th Floor, New York, NY 10036
[redacted]

<!--[if !vml]--><![endif]-->

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2281456

From: Ens, Amanda [redacted]
Sent: 4/7/2017 12:24:59 PM
To: jeffrey E. [jeevacation@gmail.com]; Richard Kahn [redacted]
Subject: EU BANKS: BIG EQUITY OUTFLOWS BUT REMAIN UPBEAT ON REFLATION TRADE: SALES TOP PICKS = SOC GEN, INTESA, NORDEA
Attachments: image001.gif; image001jpg01D2AF7627BB3E30.jpg; image012png01D2AF7627BB3E30.png; image014jpg01D2AF762A2ADEA0.jpg; image015jpg01D2AF762A2ADEA0.jpg; image016jpg01D2AF762A2ADEA0.jpg; image017jpg01D2AF762A2ADEA0.jpg; image018jpg01D2AF762A2ADEA0.jpg

Importance: High

We remain positive on banks that can make acceptable returns in the current environment and are geared into the upside when rates begin to recover... **ING, KBC, Intesa, Unicredit, SocGen, Erste, BKIR are all Buy rated**.

Global Equities
Specialist Sales – European Financials

Bank of America Merrill Lynch

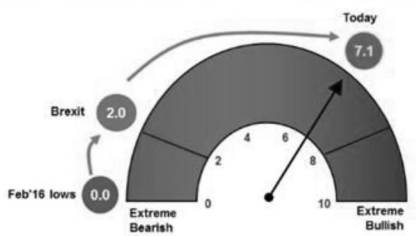
MAR disclosure

EU BANKS: BIG EQUITY OUTFLOWS BUT REMAIN UPBEAT ON REFLATION TRADE

Spec Sales Comment:

Big Equity outflows but we see this is a pause not a reversal
BofAML latest flow show data this morning shows the largest equity outflows in 40 weeks and first outflows YTD (click here). Our BofAML Bull & Bear Indicator is now at 7.1, the highest level since Jul'14 and not far from "sell" signal. So is this just a pause for breath in the reflation trade? BofAML strategists think so. In our updated thoughts this morning we think reflation is real so stay long equities, short rates, selectively long USD (click here).

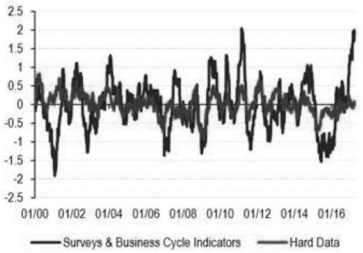
Chart 12: BofAML B&B Indicator (scale from 0 to 10)



Source: BofA Merrill Lynch Global Investment Strategy

Why do we remain bullish the reflation trade?
The main reasons for equity investor concern in recent weeks = the gap between hard and soft data, plus the delay in the Trump fiscal package

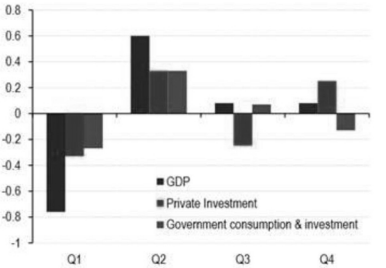
Chart 1: The gap between hard and soft data is a concern to investors



Source: BofA Merrill Lynch Global Research, Bloomberg

Chart 2: Mediocre US Q1 data partly down to seasonal adjustments

Residual seasonality in GDP growth from 1985 to 2015

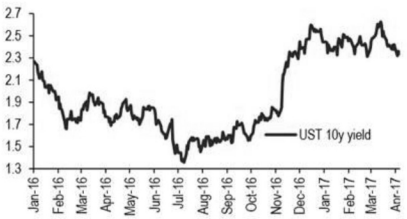


Source: Cleveland Federal Reserve

We continue to believe in the reflation theme because:

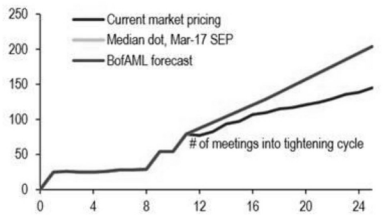
1. **Strength in the global economy is genuine** - European PMIs are at 6 year highs, Chinese and Japanese PMIs continue to improve too. In fact ~90% of PMIs globally are above 50 and 60% have increased in the last 3 months.
2. **Earnings revisions and Global Wave point to continued upturn** - earnings revisions now above 1.0 for the first time since 2011.
3. **We expect Trump to deliver on tax, even if it is smaller than hoped for** - should such a package be put together it would likely support the Trump trade once again after the failure to reform Obamacare
4. **Bond markets are being too sanguine about the likely pace of Fed tightening** - the Fed funds curve is once again well below the dot plot. We continue to see upside in yields if and when the market becomes more convinced that the soft data is right.

Chart 7: Bond yields have pulled back from FOMC highs



Source: Bloomberg

Chart 8: As the market refuses to price the dot plot



Source: BofA Merrill Lynch Global Research, Bloomberg

European Banks holding up better than US Peers on pull back

In Banks, the reoccurring feedback from investors has been that clients have rotated out of US banks and into European banks. This conflicts with our latest Fund Manager Survey which suggested allocation to European Banks fell the most of any sector MoM in the first two weeks of March, however, its true European Banks have quickly reversed the performance gap to US peers. The spread between the SX7E and S5BANKX Index is back to pre-US election levels.

What the EU banks bulls are saying:

EUR rates are going higher it's just a matter of timing, positive EPS revisions continue, EU is starting to see pockets of volume growth and asset yield recovery, credit spreads have been tightening YTD and

attractive valuations of EU banks vs. US peers (EU banks on 12.0x 2017E P/E vs. US Banks on ~14x and some EU banks still on a large discount vs 10-year historical median P/B valuations).

What the EU banks bears are saying:
EU macro declining, US lead re-flation trade cooling (tax, deregulation, healthcare headwinds) and toppy multiples/high ownership of EU banks going into Q1 results. They believe the pressure will be off Draghi to act on the deposit rate if the macro starts to reverse which may cause people to push back the assumed timing of European rate hikes and tapering. The French election is also a big risk factor which is clearly holding back some global investors from buying into Europe.

Rates Update
Consensus has started to factor in the higher rate outlook in Europe. The bears are pointing out that these probabilities have fallen a lot this week while the bulls argue it's just a matter of timing.

I monitor market expectations for ECB normalisation in rates using the World Interest Rate Probability (WIRP) function on Bloomberg. It's been very volatile recently. I currently see the market is pricing a 16.6% probability of a EUR rate hike before the end of 2017 (row 6, column 2 below). a 32.7% probability in the next 12 months (row 9, column 2) and a 67.6% probability in the next 18 months.

Euro Zone | Instrument OIS: Eurozone OIS - Deposit R | Current Rate -0.40
1) Overview | 2) Future Implied Probability
Current Implied Probabilities | 3) Add/Remove Rates
Dates ○ Meeting ● Calculation | Calculated 04/07/2017 | Based on rate -0.40

Meeting	Prob Of Hike	Prob of Cut	-0.6	-0.5	-0.4	-0.3	-0.2	BPS
04/27/2017	0.0%	2.4%	0.0%	2.4%	97.6%	0.0%	0.0%	-0.2
06/08/2017	0.0%	3.3%	0.0%	3.3%	96.7%	0.0%	0.0%	-0.3
07/20/2017	2.1%	3.2%	0.0%	3.2%	94.6%	2.1%	0.0%	-0.1
09/07/2017	7.2%	3.1%	0.0%	3.1%	89.7%	7.1%	0.1%	0.4
10/26/2017	8.8%	3.0%	0.0%	3.0%	88.2%	8.6%	0.2%	0.6
12/14/2017	16.6%	2.8%	0.0%	2.7%	80.6%	15.6%	1.0%	1.5
01/25/2018	21.6%	2.6%	0.0%	2.6%	75.8%	19.6%	1.9%	2.1
03/08/2018	29.4%	2.3%	0.0%	2.3%	68.2%	25.4%	3.7%	3.1
04/26/2018	32.7%	2.2%	0.0%	2.2%	65.1%	27.5%	4.8%	3.6
06/14/2018	41.4%	1.9%	0.0%	1.9%	56.7%	32.5%	7.8%	5.0

Historical Analysis for Meeting 04/27/2017 | 4) Add/Remove Series

As a reminder our research team estimate that euro area banks could see as much as €26bn in earnings uplift from a return of ECB rates to zero. This would represent a 25% uplift to profits - a big prize when it happens (click here for report).

What to buy in banks if you share our view on sustained reflation?
We remain positive on banks that can make acceptable returns in the current environment and are geared into the upside when rates begin to recover... **ING, KBC, Intesa, Unicredit, SocGen, Erste, BKIR are all Buy rated**.
Top picks:

Buy Soc Gen, PO €55
- Still fourth worst performer in the SX7E YTD due to French election overhang.
- Yet reported a strong set of Q4 results, beating on P&L, capital and dividend which comforts our view that the stock is set for re-rating.
- Continues to tick a number of boxes offering a dividend yield of 5.1% in 2017E, an attractive valuation of 0.79x 2017e TNAV, solid capital position and has strong EPS momentum.
- Our EPS (2017 and 2018) is 10% above consensus with further upside from CIB, Russia recovery and Corporate Center
- Stronger capital position allows for growth (organic and bolt-on M&A)

Buy Intesa, PO €2.80
- On NPEs, capital, profitability, operating trends, and cash payouts, Intesa stands above other Italian banks in our view.

- ISP will pay a dividend (confirmed) equivalent to an 8.0% yield vs. a 4.0% European banks average and on our estimates
- Italian banks are trading at a PNAV discount to ISP but their profitability is half that of ISP's and their capital is lower
- ISP retains the lowest (gross/net) Italian NPE ratio and in 4Q16 NPE were down yoy by 8% gross/10% net.
- Shares have suffered from the uncertainty related to a possible tie-up with insurer Generali - still the seventh worst performing bank in the SX7E YTD

Also remain very bullish on market exposed Nordic banks
This morning we reiterate our preference for Nordic banks (click here for report) with more market exposed revenues and reiterate our **Buy ratings on Danske Bank, Nordea, DNB and SEB** ahead of Q1 results. We expect to see good fee /trading income in Q1 on the back of strong AUM and continued high activity levels.

The relative P/E premium of Nordic banks vs. the sector is now 7% vs. a long term average of 11%. We also note that Nordic banks are expected to continue to deliver close to 4% better ROTE (2017-19E) and have a lower beta.

Chart 1: Danske Bank remains best capital return story (Capital buffers as % of market cap)

Source: BofA Merrill Lynch Global Research estimates

Please let me know if you would like to discuss in more detail or meet any of our analysts on the above reports.

Kind regards,

Russell Quelch
European Financials Specialist Sales
Bank of America Merrill Lynch

[redacted]

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Breaking: Live: Senate votes to confirm Gorsuch

with president at his estate

By Annie Linskey | GLOBE STAFF APRIL 07, 2017

WASHINGTON — For former Harvard Law professor Alan Dershowitz and his wife, their recent dinner at the Mar-a-Lago club in Florida was a chance to dine and catch up with old friends. Then President Trump showed up.

"Everyone stood up and clapped," recalled Dershowitz, who lives in South Florida during the Massachusetts winters.

Toward the end of the evening, Trump stopped by the table for an extended chat, but not about the Trump-branded chocolate cake. The mogul-turned-president wanted to discuss the prospects for Israeli and Palestinian peace with Dershowitz, who is well-known for his hawkish, pro-Israel views.

"He pulled me aside," Dershowitz recalled. "He wanted to talk to me privately about the Middle East."

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The March 18 encounter provides a window into the free-wheeling and unconventional policy making employed by Trump, who prizes spontaneity. As a business tycoon, he liked to keep an open schedule that allowed for impromptu meetings; it's a style difficult to replicate in the White House but can work among the handpicked people who frequent Mar-a-Lago.

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Comments

In this instance, Dershowitz was a guest of Trump's buddy and Mar-a-Lago member Chris Ruddy, the CEO of the conservative news source Newsmax. The former professor soon found himself immersed in a Washington power-player schmooze-fest. The mood at the club was light and fun. Vice President Mike Pence stopped over and complimented Dershowitz on his frequent cable TV appearances. Commerce Secretary Wilber Ross said "hi." A singer crooned "Don't Cry for Me Argentina."

When Trump came over, Dershowitz, a Democrat mostly known for his lefty views, shared his perspective on the National Security Agency, the fate of the Ninth Circuit Court of Appeals, Trump's travel limits on immigrants from majority-Muslim countries, and, most critically, peace between Israel and its Arab neighbors.

The Israeli paper Haaretz later reported that Trump asked Dershowitz to contact Prime Minister Benjamin Netanyahu of Israel and convey the president's belief that peace could be achieved now. In his interview with the Globe, Dershowitz wouldn't confirm or deny the account.

The atmosphere at Mar-a-Lago raises questions. Critics have pointed to Trump's club as an example of how access to the president can be purchased. The club jacked up its initiation fee to $200,000 from $100,000 after Trump became president. Members have a front row seat to history. Thursday night Chinese President Xi Jinping and his wife dined there as part of a summit with Trump. He also feted Japanese Prime Minister Shinzo Abe at the club .

For Dershowitz, it helped greatly that he was at Mar-a-Lago as a guest of Ruddy. Ruddy, it turned out, had seen Trump that day at the golf course and mentioned that Dershowitz and his wife would be among the guests at his table of six.

In Ruddy's re-telling, when Dershowitz's name came up that afternoon on the links Trump offered praise for him because he'd gone on TV and defended Trump's

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Comments

Dershowitz wouldn't repeat what Trump told him privately but felt comfortable recounting the parts of the their conversation that occurred in front of other dinner guests.

Trump "clearly had subjects he wanted to talk about. It was his agenda," Dershowitz said. "He told me he thought in the Middle East, they are ready for a deal."

Trump explained that he'd spoken to Palestinian leader Mahmoud Abbas and sensed that he was ready for a peace deal, Dershowitz said.

"I responded by saying, 'the Palestinians say that to every new president,' " Dershowitz said, offering Trump a dose of skepticism.

"He said 'Now I think they're really ready,' " Dershowitz added. "I said, 'You have to test them. ... You have to test them, it's not enough to just hear 'they're ready.'

"He shook his head in apparent agreement," Dershowitz said.

Dershowitz said Trump made it clear he was aware that the former professor is "very friendly" with Netanyahu.

And the Israeli media is reporting that Dershowitz was tapped to be a back channel sorts between Netanyahu and Trump. This chatter prompted some to wonder whether Trump's son-in-law Jared Kushner, who'd been tasked to be the point person on a possible peace deal, was on the outs.

But Dershowitz said that's not the case. "The president said, 'I know you know Jared from Harvard. Be in touch with him." "

And Dershowitz added that he doesn't have a role, formal or informal, in working on behalf of the administration to jump start peace talks. "This was as a one off," he said.

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Middle East, ask me.'"

Comments

Annie Linskey can be reached at annie.linskey@globe.com.

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Hess Corp.

Inflection point: adding Hess to BofAML's US 1 'best ideas' list

Bank of America Merrill Lynch

Reiterate Rating: BUY | PO: 80.00 USD | Price: 49.97 USD

Equity | 11 April 2017

Short interest ratio: catalyst for recovery

Over the past six months Hess has been one of the most volatile stocks in the sector, facing headwinds from a significant increase in short interest that has exaggerated volatility. From discussions with investors, the arguments against Hess seem to begin and end with a combination of declining production and an expanding balance sheet – all part of the deliberate portfolio choices that favored completing major projects at the expense of short cycle production. We expect this to end in 2Q17 with a rebound in oil and gas production starting in 2H17 and critically, an inflection in free cash flow that we expect will return Hess to free cash flow with the flexibility to re-up investment in the Bakken. We thus would view Hess as a dangerous 'short' for investors seeking to hedge other portfolio risks.

Inflection point on multiple levels right around the corner

We believe Hess' investment case is approaching an inflection point on multiple levels. We expect oil and gas production to trough in 2Q17, with a rebound of 60,000 boepd or 22%, by 4Q17 marking the single biggest sequential change in production of any company in the sector. This is likely to kickstart an extended period of growth in 2018/19 but with the contribution from Guyana driving a step change in Hess' growth trajectory through 2025. Near term, we think Hess is also poised for an inflection in free cash flow that is reasonably $1bn annualized, with $700mm irrespective of oil prices. Versus consensus operating cash flow of ~$1.9bn in 2017, this stands out as the biggest swing in free cash of any company in the sector.

Adding Hess to US 1 'best ideas' list

After a year of waiting, we believe the inflection point in Hess' investment case is just around the corner, with the broader sector pullback positioning the shares with amongst the highest upside in the sector as implied by our price objectives. At current levels, Hess 'discounts' strip oil prices. Under our base case, which assumes a rebound in oil prices towards $70 from 2020 fair value is reasonably ~$80 per share. If *non-producing* asset value from Guyana is included we estimate this would be closer to $90. BofAML's US1 list is a collection of the firm's best investment ideas managed with the goal of providing superior investment performance over the long term. For Hess, we believe the combination of catalysts, short interest and absolute value can drive a period of strong relative outperformance vs peers. For this reason, Hess replaces DVN as the energy stock on BofAML's US 1 list.

Estimates (Dec)

(US$)	2015A	2016A	2017E	2018E	2019E
EPS	(3.92)	(4.94)	(3.75)	(1.46)	(0.76)
GAAP EPS	(10.77)	(19.92)	(3.75)	(1.46)	(0.76)
EPS Change (YoY)	NM	-26.0%	24.1%	61.1%	47.9%
Consensus EPS (Bloomberg)			(3.03)	(2.09)	(0.45)
DPS	1.00	1.00	1.00	1.00	1.00

Valuation (Dec)

	2015A	2016A	2017E	2018E	2019E
P/E	NM	NM	NM	NM	NM
GAAP P/E	NM	NM	NM	NM	NM
Dividend Yield	2.0%	2.0%	2.0%	2.0%	2.0%
EV / EBITDA*	17.2x	NM	9.9x	6.4x	5.4x
Free Cash Flow Yield*	-13.2%	-8.7%	-3.8%	-0.3%	3.7%

* For full definitions of *IQmethod℠* measures, see page 11.

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Stock Data

Price	49.97 USD
Price Objective	80.00 USD
Date Established	8-Dec-2016
Investment Opinion	B-1-7
52-Week Range	45.12 USD - 65.56 USD
Mrkt Val (mn) / Shares Out (mn)	15,656 USD / 313.3
Average Daily Value (mn)	198.56 USD
BofAML Ticker / Exchange	HES / NYS
Bloomberg / Reuters	HES US / HES.N
ROE (2017E)	-8.6%
Net Dbt to Eqty (Dec-2016A)	26.1%

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Refer to important disclosures on page 12 to 14. Analyst Certification on page 10. Price Objective Basis/Risk on page 10.

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Timestamp: 11 April 2017 05:30AM EDT

iQprofile℠ Hess Corp.

iQ*method℠ – Bus Performance

(US$ Millions)	2015A	2016A	2017E	2018E	2019E
Return on Capital Employed	-8.5%	-21.0%	-3.6%	-0.9%	0.1%
Return on Equity	-5.4%	-9.0%	-8.6%	-3.7%	-2.1%
Operating Margin	-1,197.3%	-247.2%	-25.4%	-5.0%	0.5%
Free Cash Flow	(2,061)	(1,359)	(592)	(50)	574

iQ*method℠ – Quality of Earnings

(US$ Millions)	2015A	2016A	2017E	2018E	2019E
Cash Realization Ratio	NM	NM	NM	NM	NM
Asset Replacement Ratio	1.0x	0.6x	0.9x	0.9x	0.9x
Tax Rate	18.8%	41.0%	16.2%	21.9%	8.4%
Net Debt-to-Equity Ratio	19.2%	26.1%	34.9%	40.7%	40.5%
Interest Cover	-10.1x	-31.1x	-3.8x	-1.0x	0.1x

Income Statement Data (Dec)

(US$ Millions)	2015A	2016A	2017E	2018E	2019E
Sales	286	4,182	4,379	5,704	6,359
% Change	-98.1%	1,363.2%	4.7%	30.3%	11.5%
Gross Profit	(2,606)	4,182	4,379	5,704	6,359
% Change	NM	NM	4.7%	30.3%	11.5%
EBITDA	1,155	(5,482)	2,005	3,097	3,646
% Change	-84.3%	NM	NM	54.5%	17.7%
Net Interest & Other Income	(340)	(332)	(289)	(297)	(304)
Net Income (Adjusted)	**(1,113)**	**(1,531)**	**(1,174)**	**(456)**	**(246)**
% Change	**NM**	**-37.6%**	**23.3%**	**61.1%**	**46.0%**

Free Cash Flow Data (Dec)

(US$ Millions)	2015A	2016A	2017E	2018E	2019E
Net Income from Cont Operations (GAAP)	(3,056)	(6,132)	(1,126)	(408)	(246)
Depreciation & Amortization	3,955	3,413	2,857	2,962	3,188
Change in Working Capital	80	(47)	0	0	0
Deferred Taxation Charge	(1,319)	2,200	(228)	(128)	(13)
Other Adjustments, Net	2,321	1,361	357	323	369
Capital Expenditure	(4,042)	(2,154)	(2,453)	(2,798)	(2,725)
Free Cash Flow	**-2,061**	**-1,359**	**-592**	**-50**	**574**
% Change	**-98.0%**	**34.1%**	**56.4%**	**91.6%**	**NM**

Balance Sheet Data (Dec)

(US$ Millions)	2015A	2016A	2017E	2018E	2019E
Cash & Equivalents	2,716	2,732	1,974	1,974	1,974
Trade Receivables	847	768	768	768	768
Other Current Assets	841	776	776	776	776
Property, Plant & Equipment	26,352	19,941	18,886	18,299	17,412
Other Non-Current Assets	3,439	4,404	4,404	4,404	4,404
Total Assets	**34,195**	**28,621**	**26,807**	**26,220**	**25,334**
Short-Term Debt	86	112	112	112	112
Other Current Liabilities	2,542	2,139	2,088	2,036	1,982
Long-Term Debt	6,544	6,694	6,694	7,105	6,844
Other Non-Current Liabilities	4,622	4,085	4,085	4,085	4,085
Total Liabilities	**13,794**	**13,030**	**12,979**	**13,338**	**13,023**
Total Equity	**20,401**	**15,591**	**13,828**	**12,883**	**12,311**
Total Equity & Liabilities	**34,195**	**28,621**	**26,807**	**26,220**	**25,334**

* For full definitions of *iQmethod℠* measures, see page 11.

Company Sector

Oils

Company Description

Hess Corp (HES) is a mid-sized oil and gas company with 1.0bn boe of proved reserves at the end of 2015. E&P operations are focused in the US onshore, deepwater GOM, North Sea, West Africa oil, and Asian natural gas.

Investment Rationale

Our house view is that oil should rebound long term to $75 WTI / $80 Brent. Investment case anchored by exploration prospects led by Guyana. Added to this, it has a strong balance sheet, low risk production visibility in the Bakken and a stable international base. As such, we view HES' valuation as attractive and maintain our Buy rating.

Stock Data

Average Daily Volume	3,973,678

Quarterly Earnings Estimates

	2016	2017
Q1	-1.72A	-1.21E
Q2	-1.11A	-1.19E
Q3	-1.12A	-0.72E
Q4	-1.01A	-0.63E

Bank of America Merrill Lynch

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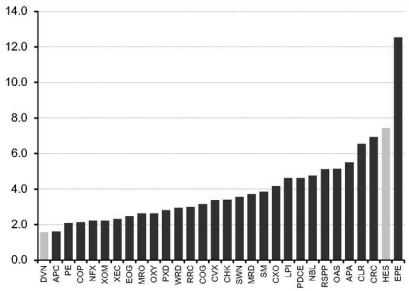
Adding Hess to BofAML US1 list

Inflection point

Over the past six months Hess has proven to be one of the most volatile stocks in the sector, facing extraordinary headwinds from a significant increase in short interest that has exaggerated volatility of what is already one of the more highly levered oil stocks in the sector. From discussions with investors, the arguments against Hess begin and end with a combination of declining production and expanding balance sheet – all part of the deliberate portfolio choices that favored completing major projects at the expense of short cycle production.

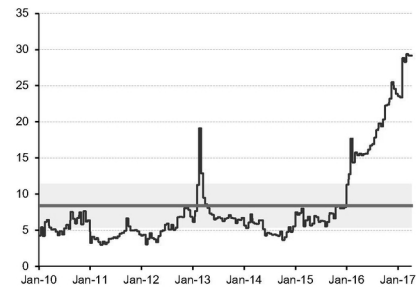
This cycle ends in 2Q17 with an expected rebound in oil and gas production starting in 2H17 and critically, an inflection in free cash flow that by our estimates should return Hess to free cash flow with the flexibility to re-up investment in the Bakken. We thus view Hess as a dangerous short for investors seeking to hedge other portfolio positions.

Exhibit 1: Short interest ratio (days to cover) US oils



Source: Bloomberg; BofA Merrill Lynch Global Research estimates

Exhibit 2: Hess short interest ratio (mm shares)



Source: Bloomberg; BofA Merrill Lynch Global Research estimates

In our view, any meaningful reduction in short interest could drive an outsize response to the improving operating outlook that we expect to start in 2H17 and can be summarized as follows:

- By our estimates, oil and gas production troughs in 2Q17 as Bakken production stabilizes before recovering through year-end. With start-up of the first of two major projects (NMB[1]) and incremental production in the US GoM, we anticipate growth in oil and gas production of ~60,000boepd or 22% between 2Q17 & 4Q17.

- Planned increase in Bakken rig count points to an exit rate of ~105–110 kboepd up from 90-95 kboepd in 1Q17 for an intra-year growth rate of ~16% underpinned by a step up to 6 rigs from 2 at the start of the year. We expect Bakken growth to continue in 2018 and 2019 at ~16% yoy with upside from larger completions.

Management guidance suggests exit rate production in 2017 of ~335,000 boepd; start-up of the second of Hess' major projects (Stampede) adds 15,000 boepd from 1H18 (est); along with a resumption of growth by resurgent operator Aker BP at Valhall (Hess 64%) we expect top line growth of 15% in 2018 with a FY contribution and continued Bakken ramp contributing to ~10% growth in 2019 including first oil from Guyana.

[1] North Malay Basin, adding 20,000 boepd starting in Sep 2017

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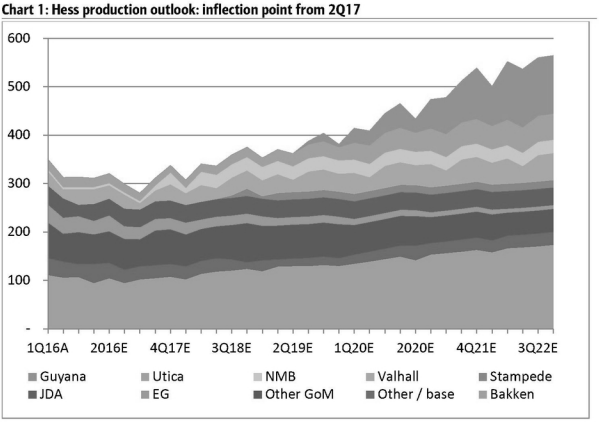
In other words, 2Q17 marks the low point in oil and gas production, with momentum accelerating in 2H17 to kick start a multi-year period of growth.

Chart 1: Hess production outlook: inflection point from 2Q17

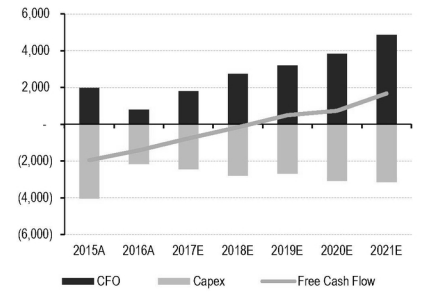


Source: BofA Merrill Lynch Global Research estimates

Critically, Hess has multiple levers to pull that reverse production declines as cash becomes available from completion of NMB and Stampede.

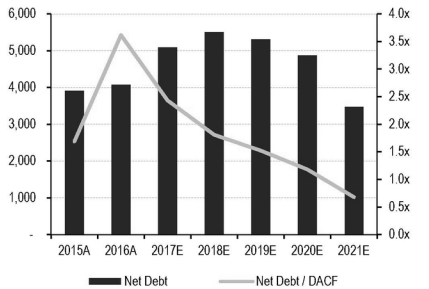
Planned spending to complete NMB and Stampede is ~$700mm in 2017; with completion we expect this to drop closer to $200mm in 2018 so that before any contribution from operating cash flow from these projects we expect Hess 'apples to apples' capex to move lower in 2018 driving an inflection in free cash flow.

Exhibit 3: Free cash flow turns positive in 2018



Source: BofA Merrill Lynch Global Research estimates

Exhibit 4: with an accelerating decline in net debt



Source: BofA Merrill Lynch Global Research estimates

Our assumptions include a likely project sanction of the first phase 'early production system' at the Liza discovery in 2Q17. However, based on discovered oil to date that we believe now easily exceeds 2bn barrels, we believe Hess is on the cusp of a multi-year period of growth that is material for a company of its size. Critically, we believe most commentators have not yet included the cash flow contribution from Guyana in Hess' estimates given visibility that barely looks past 2018. However, with first oil now likely

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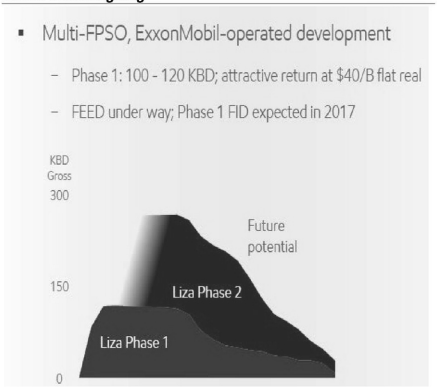
in 2H19, we view final investment decision (FID) – and an exploration program that yields one well result every 6-8 weeks as a catalyst to rerate Hess over time.

Liza area moving towards 2bn boe

Operator Exxon recently confirmed the latest exploration test in Guyana 'Snoek' as the latest discovery in the Liza development area, with ~82ft of net pay and in line with pre drill expectations we are led to believe is in the 200-300mm boe range. Recall from our discussions with management, Snoek was characterized as a smaller but distinct target, updip of Liza, but lower risk.

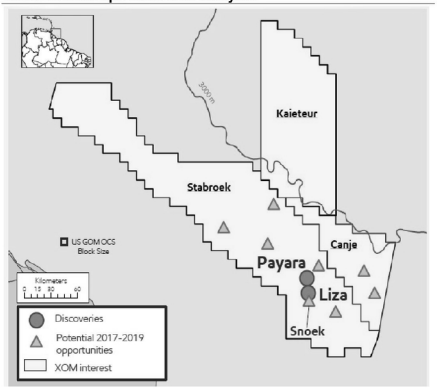
The well was drilled in 26 days to a depth of ~17,000ft in 5,128ft of water 5 miles south west of Liza #1, as shown in the graphic below; the Stena Carron drill ship has now relocated to the next well test, the 'Liza #4' appraisal, where we anticipate results by end April but with the possibility of a drill stem test in a success case that may push the well result into mid-May.

Exhibit 5: Liza targeting



Source: Exxonmobil

Exhibit 6: Exxon operated blocks in Guyana



Source: Exxonmobil

Critically, 'Snoek' reinforces management's prior characterization of the Stabroek block as moving towards a 'DHI play' meaning the risk profile of incremental exploration improves - a critical factor for the next well in queue, the Payara #2 appraisal that will also target a deeper test (Pacuma) scaled with a pre drill target of ~1bn boe. The next prospect, Liza lookalike named 'Turbot will likely be spud around mid-year.

From our discussions with Hess and the operator we summarize our understanding as follows:

- Operator XOM had previously framed the discovered potential in the Liza / Payara at 1.5bn – 2.0bn boe, subject to completion of two planned additional appraisal wells. Quoting EVP Mark Albers and CEO Darren Woods

'The success at Payara combined with the additional oil pay discovered with Liza-3 brings the total discovered resource on the block to somewhere between 1.4 billion oil equivalent barrels and 2 billion oil equivalent barrels.'

' to clarify, what we have found – not potential upside, but what we have found is 1.4 billion to 2 billion BOE. The upside is multi-billion barrel unrisked potential'.

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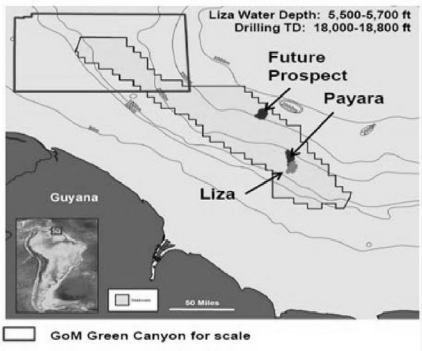
- Snoek and with Liza deep previously likely moves recoverable resource closer to the upper end of this range 2bn boe before Liza #4 and Pacuma, providing line of sight for at least a 4 FPSO development starting in 2019.

- After Liza 4, the Stena Carron drillship will move back to Payara to drill an appraisal well which will also test a deeper prospect 'Pacuma tail'. Where pre-drill prospect size is scaled at about 1bn boe. The next prospect (Turbot) will then be spud south east of Payara. Note is that if Payara 2 is successful, this would likely add another 'boat' with capacity of 150,000 boepd.

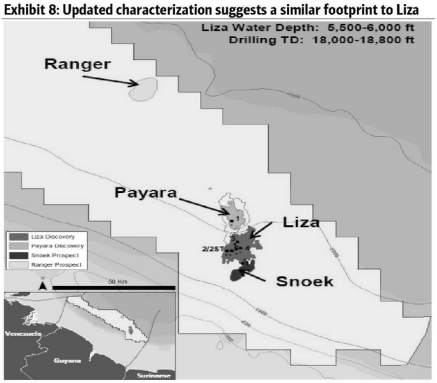
The graphics below characterize Hess view of Payara and Snoek. We assume the 1bn boe Pacuma prospect is the light green area below Payara.

Exhibit 7: Initial characterization of Payara



Source: Hess

Exhibit 8: Updated characterization suggests a similar footprint to Liza



Source: Hess

Again quoting ExxonMobil management:

'Just as we progressed rapidly at Liza, we'll move quickly to develop Payara if the delineation well is successful.'

Recall that Hess management has suggested Payara will 'definitely be commercial'. However at this early stage we assume no value for Payara in our assessed value of Hess' not least as any attempt at precision is obviously premature. But with discussions with management suggesting scenarios through appraisal where Payara is a lookalike to Liza, we believe a 'plus three year' development scheme is a reasonable basis to frame option value in a success case.

Under our $70 Brent base case, the theoretical NPV would be around $10/sh. This is on top of the approximate $12-14/ share value we estimate is reasonable for Hess from the existing Liza discovery. Note we continue to assume about 400,000 bpd gross development scenario–reviewed again below to reflect the latest project proposal submitted to the Guyana Government which now targets first production in 2H19.

Note we assume negligible value for natural gas revenue in this latest iteration, thus the range of $12-$14 for Liza mentioned above and $22-$24 for Liza / Payara. The table below assumes gas valued at $1 / mmcfe.

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Table 1: Notional multi-phase development at Guyana: about $22/sh to Hess

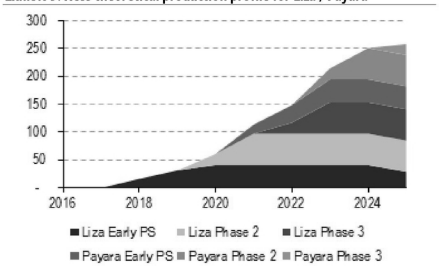
	Gross Barrels (mmboe) (mmboe)	Full Project NPV $MM $mm	Hess 30% Interest NPV $mm	NPV net to Hess $/sh
Liza				
Early Production				
System	425	4,258	1,277	$3.9
Phase 1	600	4,932	1,480	$4.6
Phase 2	600	3,821	1,146	$3.5
Liza Total	**1,625**	**13,010**	**3,903**	**$12.0**
Payara (spec)				
Early Production				
System	425	3,392	1,018	$3.1
Phase 1	600	3,668	1,100	$3.4
Phase 2	600	2,682	805	$2.5
Payara spec Total	**1,625**	**9,742**	**2,923**	**$9.0**
Guyana Total	**3,250**	**22,753**	**6,826**	**$21.1**

Source: BofA Merrill Lynch Global Research estimates; Hess shares fully diluted 324.2mm shares after preference convert

Note that at current strip oil prices of ~$55 Brent, this is closer to $14.4/sh of which Payara is ~$6/sh or $2.0bn. On a 'risked' basis, we believe this is a reasonable development scenario representative of any incremental discovery that resembles Liza recalling that the partners have identified over 20 additional drilling prospects. On the assumption of a 'plus three year' development scenario after Liza, the potential impact on incremental production and cash flow is significant for Hess while the cumulative impact also becomes significant for XOM.

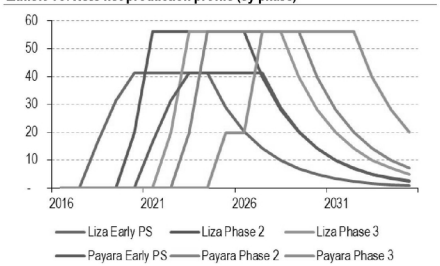
The charts below show our latest assessment of how a compound timeline for a Liza / Payara development could look, if Payara as a project does indeed prove to be a look alike to Liza.

Exhibit 9: Hess theoretical production profile for Liza / Payara



Source: BofA Merrill Lynch Global Research estimates

Exhibit 10: Hess net production profile (by phase)



Source: BofA Merrill Lynch Global Research estimates

Critically, Guyana is now being described as a 'DHI play' meaning seismic and core have been sufficiently calibrated as to provide direct hydrocarbon indicators and hence de-risking future exploration tests. This appears confirmed again by the latest 'Snoek' success.

XOM's development plan calls for an FPSO (floating production and storage offloading vessel) with production capacity of about 150,000 boepd for every 450mm barrels of recoverable reserves, with plateau production extending up to 10 years. We suggest management's commentary supports gross production capacity from current discovered resource of at least 600,000 boepd.

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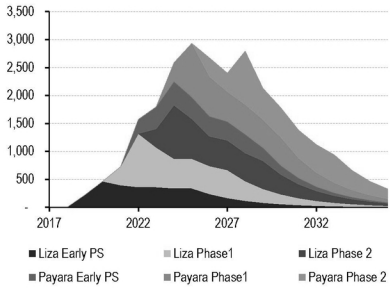
Impact on cash flow

While the impact on production is significant, we suggest the impact on cash flow is transformational for Hess. Referencing the charts below:

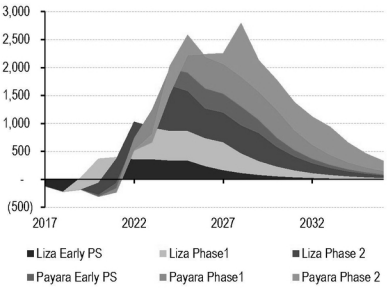
- Under our base case that assumes $70 oil from 2020, we estimate operating cash flow net to Hess would reach over $2.5bn;
- Net free cash flow peaks at over $2bn with a net cash outflow at any point in the development of ~$300mm.

Chart 2: Hess operating cash flow contribution: Guyana ($70 base case)



Source: BofA Merrill Lynch Global Research

Chart 3: Hess free cash flow contribution: Guyana ($70 base case)



Source: BofA Merrill Lynch Global Research

While first oil in 2019 is only the early stage of development, it is enough in our view to provide visibility on multiple compression perceived absent from Hess' investment case given its focus on short cycle development. However, after the low point in production in 2Q17 we suggest Hess has both – short cycle, comprising not only the Bakken but tie back opportunities across established infrastructure in Norway and the US GoM – and long cycle in the shape of a transformational opportunity in Guyana, that becomes tangible with a likely FID in 2Q17.

Impact on valuation

In our view, an imminent inflexion point in free cash flow comes with a step change in value recognition for Hess. Momentum from a >20% jump in production in the six months of the second half of 2017 carries growth through 2018, with Guyana accelerating for a decade from 2019. At our base case we suggest this leaves Hess 'discounting' current strip oil prices at current levels of ~$50 / share.

The table below sets our PO at our target mid cycle multiple of 5.5x EV/DACF; note this does not include any value for non-producing Guyana resource value that we estimate at ~$6/share.

Table 2: At strip oil prices, Hess looks fairly valued based on a target multiple of 5.5x EV/DACF

	2015	2016	2017e	2018e	2019e	2020e	2021e
Shares Outstanding	284	310	313	313	323	324	324
Market Cap	13,119	13,334	13,415	13,415	13,415	13,415	13,415
Non-producing Guyana NAV				-	-	-	-
Net Debt	3,914	4,074	5,136	6,224	6,985	7,798	7,866
Preference shares		557	557	557			
EV	17,033	17,965	19,108	20,196	20,400	21,213	21,281
DACF	2,321	1,127	1,847	2,378	2,625	3,030	3,795
Forward EV / DACF	**15.1x**	**9.7x**	**8.0x**	**7.7x**	**6.7x**	**5.5x**	

Source: BofA Merrill Lynch Global Research

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Under our base case, which assumes a rebound in oil prices towards $70 from 2020, we see fair value as reasonably around $80 per share. If non-producing asset value is included (around $3bn or ~$9/sh), we estimate this would be closer to $90.

Table 3: At our base case, we see fair value closer to $80 based on a target multiple of 5.5x EV/DACF

	2015	2016	2017e	2018e	2019e	2020e	2021e
Shares Outstanding	284	310	313	313	323	324	324
Market Cap	22,341	22,684	22,814	22,814	22,814	22,814	22,814
Non-producing Guyana NAV				-	-	-	-
Net Debt	3,914	4,074	4,832	5,243	4,983	4,441	3,020
Pref		557	557	557			
EV	26,255	27,315	28,203	28,614	27,797	27,255	25,834
DACF	2,321	1,127	2,150	3,045	3,602	4,291	5,132
Forward EV / DACF	**23.3x**	**12.7x**	**9.3x**	**7.9x**	**6.5x**	**5.3x**	

Source: BofA Merrill Lynch Global Research

BofAML US 1 list

The BofAML US1 list is a collection of the firm's best investment ideas managed with the goal of providing superior investment performance over the long term. Since the presidential election, the 'trump tax rally' that has arguably lifted the broader S&P500 on the expectation of lower corporate taxes has left most US oils lagging given the absence of any benefit from lower taxes. For Hess, we believe the catalysts are still ahead while the relative performance hurdle associated with the election has passed. For this reason, Hess replaces DVN as our energy stock on the BofAML US1 list.

Earnings updates

Marking to market for 1Q17 we update earnings as follows:

Table 4: HES Earnings Estimates

	Q1	Q2	Q3	Q4	FY	BBG Consensus
2015A	(0.98)	(0.52)	(1.03)	(1.40)	(3.92)	(3.92)
2016E	(1.72)	(1.11)	(1.12)	(1.01)	(4.94)	(4.98)
Previous	(1.72)	(1.11)	(1.12)	(1.01)	(4.94)	n/a
2017E	(1.21)	(1.19)	(0.72)	(0.63)	(3.75)	(3.03)
Previous	(1.37)	(1.19)	(0.72)	(0.63)	(3.91)	n/a
2018E	(0.40)	(0.40)	(0.35)	(0.30)	(1.46)	(2.09)
Previous	(0.40)	(0.41)	(0.35)	(0.31)	(1.47)	n/a

Source: BofA Merrill Lynch Global Research

HOUSE_OVERSIGHT_014881

Price objective basis & risk

Hess Corp. (HES)

Our price objective of $80 / share is based on a 5-year outlook which assumes a 5.5x DACF multiple and a commodity deck of $67.50 WTI and $70 Brent to which we add $10 / sh for Liza in offshore Guyana. The multiple is based on a finite timeline to delivery which is supported by core NAV.

The risks to our price objective are: 1) the oil and gas price environment, (2) slowdowns in development drilling that leave production below expectations, and (3) news flow around HES' exploratory and appraisal drilling activities that could impact the stock.

Analyst Certification

I, Doug Leggate, hereby certify that the views expressed in this research report accurately reflect my personal views about the subject securities and issuers. I also certify that no part of my compensation was, is, or will be, directly or indirectly, related to the specific recommendations or view expressed in this research report.

US - Large Cap Oils Coverage Cluster

Investment rating	Company	BofA Merrill Lynch ticker	Bloomberg symbol	Analyst
BUY				
	Anadarko Petroleum Corp.	APC	APC US	Doug Leggate
	Chevron Corp.	CVX	CVX US	Doug Leggate
	ConocoPhillips	COP	COP US	Doug Leggate
	Continental Resources Inc.	CLR	CLR US	Doug Leggate
	Devon Energy Corp.	DVN	DVN US	Doug Leggate
	EOG Resources	EOG	EOG US	Doug Leggate
	Hess Corp.	HES	HES US	Doug Leggate
	Marathon Oil Corp.	MRO	MRO US	Doug Leggate
	Marathon Petroleum Company	MPC	MPC US	Doug Leggate
	Occidental Petroleum Corp.	OXY	OXY US	Doug Leggate
	Pioneer Natural Resources	PXD	PXD US	Doug Leggate
	Range Resources Corp	RRC	RRC US	Doug Leggate
	Tesoro Corp.	TSO	TSO US	Doug Leggate
	Valero Energy Corp.	VLO	VLO US	Doug Leggate
NEUTRAL				
	Chesapeake Energy Corp.	CHK	CHK US	Doug Leggate
	Delek US Holdings, Inc.	DK	DK US	Doug Leggate
	ExxonMobil Corp.	XOM	XOM US	Doug Leggate
	HollyFrontier Corp	HFC	HFC US	Doug Leggate
	Noble Energy	NBL	NBL US	Doug Leggate
	Phillips 66	PSX	PSX US	Doug Leggate
UNDERPERFORM				
	Apache Corp	APA	APA US	Doug Leggate
	Cabot Oil & Gas Corp.	COG	COG US	Doug Leggate
	PBF Energy	PBF	PBF US	Doug Leggate
	Southwestern Energy Corp.	SWN	SWN US	Doug Leggate

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iQmethod℠ Measures Definitions

Business Performance	Numerator	Denominator
Return On Capital Employed	NOPAT = (EBIT + Interest Income) * (1 - Tax Rate) + Goodwill Amortization	Total Assets – Current Liabilities + ST Debt + Accumulated Goodwill Amortization
Return On Equity	Net Income	Shareholders' Equity
Operating Margin	Operating Profit	Sales
Earnings Growth	Expected 5-Year CAGR From Latest Actual	N/A
Free Cash Flow	Cash Flow From Operations – Total Capex	N/A
Quality of Earnings		
Cash Realization Ratio	Cash Flow From Operations	Net Income
Asset Replacement Ratio	Capex	Depreciation
Tax Rate	Tax Charge	Pre-Tax Income
Net Debt-To-Equity Ratio	Net Debt = Total Debt, Less Cash & Equivalents	Total Equity
Interest Cover	EBIT	Interest Expense
Valuation Toolkit		
Price / Earnings Ratio	Current Share Price	Diluted Earnings Per Share (Basis As Specified)
Price / Book Value	Current Share Price	Shareholders' Equity / Current Basic Shares
Dividend Yield	Annualised Declared Cash Dividend	Current Share Price
Free Cash Flow Yield	Cash Flow From Operations – Total Capex	Market Cap. = Current Share Price * Current Basic Shares
Enterprise Value / Sales	EV = Current Share Price * Current Shares + Minority Equity + Net Debt + Other LT Liabilities	Sales
EV / EBITDA	Enterprise Value	Basic EBIT + Depreciation + Amortization

iQmethod℠ is the set of BofA Merrill Lynch standard measures that serve to maintain global consistency under three broad headings: Business Performance, Quality of Earnings, and validations. The key features of iQmethod are: A consistently structured, detailed, and transparent methodology. Guidelines to maximize the effectiveness of the comparative valuation process, and to identify some common pitfalls.

iQdatabase® is our real-time global research database that is sourced directly from our equity analysts' earnings models and includes forecasted as well as historical data for income statements, balance sheets, and cash flow statements for companies covered by BofA Merrill Lynch.

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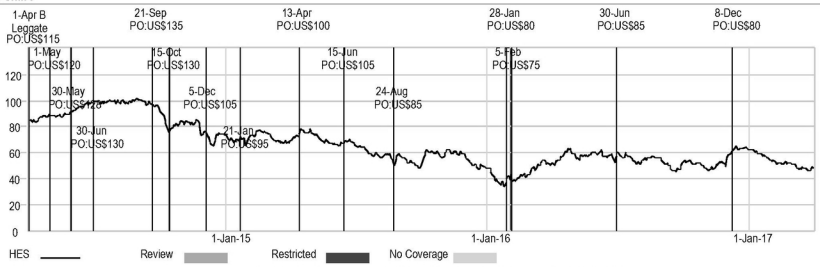
Disclosures

Important Disclosures

HES Price Chart



B: Buy, N: Neutral, U: Underperform, PO: Price Objective, NA: No longer valid, NR: No Rating

The Investment Opinion System is contained at the end of the report under the heading "Fundamental Equity Opinion Key". Dark grey shading indicates the security is restricted with the opinion suspended. Medium grey shading indicates the security is under review with the opinion withdrawn. Light grey shading indicates the security is not covered. Chart is current as of March 31, 2017 or such later date as indicated.

Equity Investment Rating Distribution: Energy Group (as of 31 Mar 2017)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	109	49.77%	Buy	84	77.06%
Hold	52	23.74%	Hold	43	82.69%
Sell	58	26.48%	Sell	34	58.62%

Equity Investment Rating Distribution: Global Group (as of 31 Mar 2017)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	1578	51.33%	Buy	979	62.04%
Hold	690	22.45%	Hold	434	62.90%
Sell	806	26.22%	Sell	381	47.27%

* Issuers that were investment banking clients of BofA Merrill Lynch or one of its affiliates within the past 12 months. For purposes of this Investment Rating Distribution, the coverage universe includes only stocks. A stock rated Neutral is included as a Hold, and a stock rated Underperform is included as a Sell.

FUNDAMENTAL EQUITY OPINION KEY: Opinions include a Volatility Risk Rating, an Investment Rating and an Income Rating. *VOLATILITY RISK RATINGS*, indicators of potential price fluctuation, are: A - Low, B - Medium and C - High. *INVESTMENT RATINGS* reflect the analyst's assessment of a stock's: (i) absolute total return potential and (ii) attractiveness for investment relative to other stocks within its *Coverage Cluster* (defined below). There are three investment ratings: 1 - Buy stocks are expected to have a total return of at least 10% and are the most attractive stocks in the coverage cluster; 2 - Neutral stocks are expected to remain flat or increase in value and are less attractive than Buy rated stocks and 3 - Underperform stocks are the least attractive stocks in a coverage cluster. Analysts assign investment ratings considering, among other things, the 0-12 month total return expectation for a stock and the firm's guidelines for ratings dispersions (shown in the table below). The current price objective for a stock should be referenced to better understand the total return expectation at any given time. The price objective reflects the analyst's view of the potential price appreciation (depreciation).

Investment rating	Total return expectation (within 12-month period of date of initial rating)	Ratings dispersion guidelines for coverage cluster*
Buy	≥ 10%	≤ 70%
Neutral	≥ 0%	≤ 30%
Underperform	N/A	≥ 20%

* Ratings dispersions may vary from time to time where BofA Merrill Lynch Research believes it better reflects the investment prospects of stocks in a Coverage Cluster.

***INCOME RATINGS*, indicators of potential cash dividends, are: 7 - same/higher (dividend considered to be secure), 8 - same/lower (dividend not considered to be secure) and 9 - pays no cash dividend.** *Coverage Cluster* is comprised of stocks covered by a single analyst or two or more analysts sharing a common industry, sector, region or other classification(s). A stock's coverage cluster is included in the most recent BofA Merrill Lynch report referencing the stock.

Price charts for the securities referenced in this research report are available at http://pricecharts.baml.com, or call 1-800-MERRILL to have them mailed.
MLPF&S or one of its affiliates acts as a market maker for the equity securities recommended in the report: Hess.
MLPF&S or an affiliate was a manager of a public offering of securities of this issuer within the last 12 months: Hess.
The issuer is or was, within the last 12 months, an investment banking client of MLPF&S and/or one or more of its affiliates: Hess.
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1Q Internet Sector Preview

1Q Preview; Expectations building on a strong 2H

Our early sector preview highlights our estimates vs. Street, early 1Q data points, and some opportunities for 1Q results for 30 stocks in our coverage group (more detailed company previews to follow). For large-caps, Street 2017 EPS estimates are down 8% YTD while the average stock price is up 9% YTD; suggesting macro and 2H optimism is driving stocks, which could continue throughout earnings season. 1Q was not without potential pressures, including ramping competition in several sectors and delayed tax refunds. A key theme for the group, in our view, is advertising & listing ranking revenue initiatives at eCommerce sites (AMZN, EBAY, EXPE), and we are constructive on all three stocks. Per our Internet sentiment ranking screen (page 7), FB, WIX, TREE have best sentiment while TWTR and TRIP have weakest.

A few early checks positive, mixed eCommerce data

Our early ad checks suggest robust overall demand, aided by somewhat easy comps vs 1Q'16, with Instagram momentum a standout. eCommerce is more mixed, with some concerns on consumer spending due to delayed tax refunds, but optimism that spending will rebound in March/April. In travel, there are modest concerns on pressure on US inbound travel, a bigger negative for Expedia than Priceline. FX spot rates for both the Euro and the Pound have depreciated 1% vs. the US$ since end of Jan.

Many key upcoming events for stocks in 2Q

Top events in 2Q include Facebook's F8 developer conference on April 18-19, Google's Marketing Next keynote on 5/23, an AWS event in San Francisco on April 18-19, expected closing Verizon's acquisition of Yahoo, Netflix's release of several key franchise including *House of Cards*, *Orange is the New Black*, *Sense8*, *Glow*, and *Unbreakable Kimmy Schmidt*, consumer wide release of Pandora Premium, Expedia's new HomeAway disclosures and, possibly, Amazon's new revenue disclosures.

We expect meet/beat EPS for several companies

We are above the Street on 2017 EPS for 16 of the 25 stocks discussed within and, of those, we are most confident in Facebook & Priceline for 1Q upside potential. We expect Facebook to benefit from robust traffic, Instagram momentum, and greater adoption of audience targeting tools. We also think Priceline can beat 1Q given strong booking trends into the quarter and a modest recovery in European travel. We are below the Street on 2017 EPS for AMZN, TRIP, and YHOO. Expedia is a top eComm/travel idea for 2Q/3Q on potential for accelerating room nights, HomeAway optimism, and less uncertainty on near-term estimates.

GOOG, AMZN & ZG interesting 1Q sentiment stocks

For large cap's, we believe GOOGL has had high recent interest given controversy around Youtube ad placements. We are not sure if Google will provide clarity on the issue on their call, but we do expect advertisers to return by 3Q and any overhang to be resolved. For Amazon, the company had new revenue disclosures in its 10-K filing, and there is growing optimism on advertising being a positive bottom-line driver. In SMID Internet, Zillow has more controversy going into 1Q as investors are once more concerned about potential regulation by the CFPB limiting the ability of agents and mortgage brokers to co-market on the platform. We remain positive on the stock due to its dominant position in online real estate and our belief that the high ROI of the ad unit (our survey suggested >6x return) will ensure that agents buy Zillow placements regardless of mortgage broker incentives. Additionally, we see earnings upside potential.

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Table 1: Key 1Q metrics for Large Cap Internet (>$5bn Market Cap)

Company	Ticker	Key 1Q Metric	BofAML Estimate
Alphabet	GOOGL	Website revenue (ex-FX) growth vs 22.3% in 4Q	21.6%
Amazon	AMZN	AWS revenue growth vs. 47% in 4Q	43% y/y
eBay	EBAY	US GMV growth trends	3.5% y/y
Expedia	EXPE	Room night growth vs. 15% in 4Q	16%
Facebook	FB	Ad revenue growth (ex-FX) vs. 54% reported in 4Q	52%
Netflix	NFLX	1Q Intl sub guidance	3.9mn
Priceline	PCLN	1Q room night growth vs. 31% in $Q	26% y/y
Snap	SNAP	Global DAU's vs. 158mn in 4Q	166mn
TripAdvisor	TRIP	Update on ad spend targets, 2017 guidance	18% S&M y/y growth
Twitter	TWTR	MAUs and y/y trend vs 319mn (+4% y/y) in 4Q	322mn MAUs (+4% y/y)
Yahoo	YHOO	Any update on acquisition timing and ongoing breach investigations	N/A
Zillow	ZG	Mortgage Revenue	$18.1mn

Source: BofA Merrill Lynch Global Research estimates

Table 2: Key 1Q metrics for Small Cap Internet (<$5bn Market Cap)

Company	Ticker	Key 1Q Metric	BofAML Estimate
BankRate	RATE	1Q revenue	$117mn
Quotient	QUOT	1Q transactions	731mn
Care.com	CRCM	US paying families	266,607 (4% y/y)
Fitbit	FIT	1Q unit sales and gross margin	3mn/39%
GoPro	GPRO	1Q unit sales and gross margin	800K/35%
GrubHub	GRUB	Gross food sales growth	26%
Match.com	MTCH	Paid Member Growth	17%
OnDeck Capital	ONDK	1Q origination growth and marketplace take rate	12% / 3%
Pandora	P	Ad revenue per listening hour growth	10%
LendingTree	TREE	Variable marketing margin growth	29% y/y
Trivago	TRVG	Qualified referral growth	56% y/y
Wayfair	W	2Q revenue growth guidance	25% y/y
Wix	WIX	Premium subscribers growth	36%
Yelp	YELP	1Q Local advertising account adds	4k (17% y/y)
Zynga	ZNGA	Online Games DAUs	17.9

Source: BofA Merrill Lynch Global Research estimates

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1Q Internet Summary Previews

We are publishing updates on 1Q industry data points and write ups on our early outlook and top 1Q earnings focus items for select stocks in our Internet coverage group (more detailed previews with various channel checks for large cap stocks to follow.) Our commentary is designed to highlight 1Q data points, stock trading opportunities and potential issues for 1Q results, and our estimates vs. consensus.

For 1Q EPS estimates, we are above the street for well over 50% of our companies under coverage, and only below on QUOT, P, RATE, and TRIP. For large caps, we have highest confidence in EPS upside for Facebook and Priceline.

Table 3: 1Q17 BofAML Estimates vs. The Street

Large Cap Stocks (>$5bn Market Cap)

Ticker	1Q17 Metric	BofA ML	Street	BofA ML vs. Street
AMZN	Revenue	$35,335	$35,255	
	EPS	$2.34	$2.28	Ahead
EBAY	Revenue	$2,210	$2,206	
	EPS	$0.49	$0.48	Ahead
EXPE	Revenue	$2,134	$2,140	
	EPS	$0.07	$0.06	Ahead
FB	Revenue	$7,905	$7,798	
	EPS	$1.14	$1.11	Ahead
GOOGL	Revenue	$20,219	$19,891	
	EPS	$9.53	$9.45	Ahead
NFLX	Revenue	$2,710	$2,644	
	EPS	$0.45	$0.45	In-line
PCLN	Revenue	$2,415	$2,441	
	EPS	$9.08	$8.75	Ahead
SNAP	Revenue	$163	$158	
	EPS	($0.18)	($0.21)	Ahead
TRIP	Revenue	$379	$377	
	EPS	$0.23	$0.27	Below
TWTR	Revenue	$535	$510	
	EPS	$0.03	$0.01	Ahead
YHOO	Revenue	$821	$815	
	EPS	$0.14	$0.14	In-line
ZG	Revenue	$239	$236	
	EPS	$0.06	$0.05	Ahead

Small Cap Stocks (<$5bn Market Cap)

Ticker	1Q17 Metric	BofA ML	Street	BofA ML vs. Street
RATE	Revenue	$117	$116	
	EPS	$0.14	$0.15	Below
CRCM	Revenue	$43	$43	
	EPS	$0.04	$0.02	Ahead
FIT	Revenue	$282	$278	
	EPS	($0.19)	($0.19)	In-line
GRUB	Revenue	$153	$153	
	EPS	$0.25	$0.24	Ahead
GPRO	Revenue	$205	$207	
	EPS	($0.39)	($0.44)	Ahead
TREE	Revenue	$127	$125	
	EPS	$0.93	$0.91	Ahead
MTCH	Revenue	$293	$308	
	EPS	$0.14	$0.13	Ahead
QUOT	Revenue	$72	$72	
	EPS	$0.01	$0.03	Below
P	Revenue	$319	$318	
	EPS	($0.49)	($0.35)	Below
TRVG	Revenue	€241	€241	
	EPS	€0.02	€0.02	In-line
WIX	Revenue	$91	$90	
	EPS	($0.05)	($0.13)	Ahead
W	Revenue	$944	$933	
	EPS	($0.49)	($0.60)	Ahead
YELP	Revenue	$201	$198	
	EPS	$0.18	$0.16	Ahead

Source: BofA Merrill Lynch Global Research, Bloomberg, as of 4/4/2017

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Our 2017 estimates vs. street

Of the 25 Internet stocks listed below in our coverage, we are above the Street on 2017 EPS on 16 stocks and below the street on 9.

Table 4: 2017 BAML Estimates vs. The Street

Large Cap Stocks (>$5bn Market Cap)

Ticker	Metric	BofA ML	Street	BofA ML vs. Street
AMZN	Revenue	$164,532	$165,158	
	EBITDA	$18,246	$19,382	
	EPS	$10.90	$12.60	Below
EBAY	Revenue	$9,458	$9,398	
	EBITDA	$3,520	$3,494	
	EPS	$2.03	$2.01	Ahead
EXPE	Revenue	$10,097	$10,010	
	EBITDA	$1,857	$1,835	
	EPS	$5.54	$5.38	Ahead
FB	Revenue	$38,546	$37,774	
	EBITDA	$24,358	$23,775	
	EPS	$5.67	$5.43	Ahead
GOOGL	Revenue	$88,636	$87,691	
	EBITDA	$43,457	$43,264	
	EPS	$41.82	$41.12	Ahead
NFLX	Revenue	$11,627	$11,221	
	EBITDA	$1,218	$1,053	
	EPS	$1.44	$1.41	Ahead
PCLN	Revenue	$12,518	$12,447	
	EBITDA	$4,784	$4,747	
	EPS	$75.35	$74.11	Ahead
SNAP	Revenue	$1,007	$1,034	
	EBITDA	($580)	($617)	
	EPS	($0.59)	($0.57)	Ahead
TRIP	Revenue	$1,647	$1,649	
	EBITDA	$346	$339	
	EPS	$1.22	$1.23	Below
TWTR	Revenue	$2,301	$2,352	
	EBITDA	$639	$564	
	EPS	$0.33	$0.27	Ahead
YHOO	Revenue	$3,369	$3,574	
	EBITDA	$848	$891	
	EPS	$0.65	$0.67	Below
ZG	Revenue	$1,062	$1,048	
	EBITDA	$215	$211	
	EPS	$0.48	$0.44	Ahead

Small Cap Stocks (<$5bn Market Cap)

Ticker	Metric	BofA ML	Street	BofA ML vs. Street
RATE	Revenue	$508	$505	
	EBITDA	$126	$126	
	EPS	$0.68	$0.70	Below
CRCM	Revenue	$172	$172	
	EBITDA	$20	$19	
	EPS	$0.43	$0.36	Ahead
FIT	Revenue	$1,625	$1,580	
	EBITDA	($156)	($120)	
	EPS	($0.37)	($0.36)	Below
GRUB	Revenue	$650	$645	
	EBITDA	$184	$181	
	EPS	$1.13	$1.10	Ahead
GPRO	Revenue	$1,307	$1,266	
	EBITDA	$66	$48	
	EPS	$0.09	($0.08)	Ahead
TREE	Revenue	$525	$515	
	EBITDA	$96	$96	
	EPS	$3.91	$4.00	Below
MTCH	Revenue	$1,285	$1,325	
	EBITDA	$462	$459	
	EPS	$0.95	$0.88	Ahead
QUOT	Revenue	$312	$288	
	EBITDA	$44	$46	
	EPS	$0.18	$0.09	Ahead
P	Revenue	$1,629	$1,621	
	EBITDA	($17)	($38)	
	EPS	($0.21)	($0.49)	Ahead
TRVG	Revenue	€1,105	€1,088	
	EBITDA	€44	€40	
	EPS	€0.05	€0.06	Below
WIX	Revenue	$420	$416	
	EBITDA	$74	$64	
	EPS	$0.31	$0.36	Below
W	Revenue	$4,169	$4,237	
	EBITDA	($48)	($59)	
	EPS	($1.55)	($1.65)	Ahead
YELP	Revenue	$895	$889	
	EBITDA	$166	$161	
	EPS	$0.99	$1.04	Below

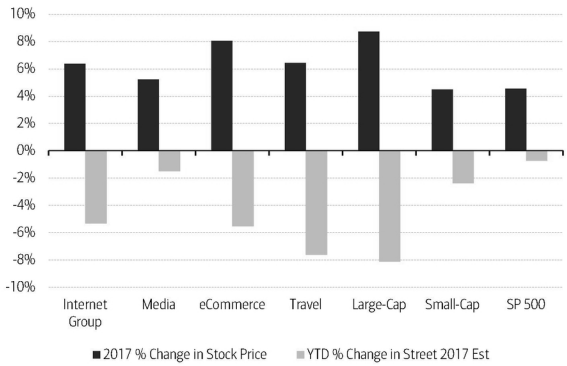
Source: BofA Merrill Lynch Global Research, Bloomberg, as of 4/4/2017

HOUSE_OVERSIGHT_014890

Stock price performance above estimate revisions

Internet sector stocks are up 6% YTD, on average, while EPS estimates for profitable companies in our coverage cluster are down 5% YTD. For large-caps over $5bn in market cap., street 2017 EPS estimates are down 8% YTD while the average stock price is up 9% YTD; suggesting macro expectations and stock rotation are having a larger impact on stock movement than earnings estimates. eCommerce leads the group, up 8% YTD with Travel up 6% and Media behind at 5%. Small Caps are lagging Large caps YTD at 4% vs. 9%.

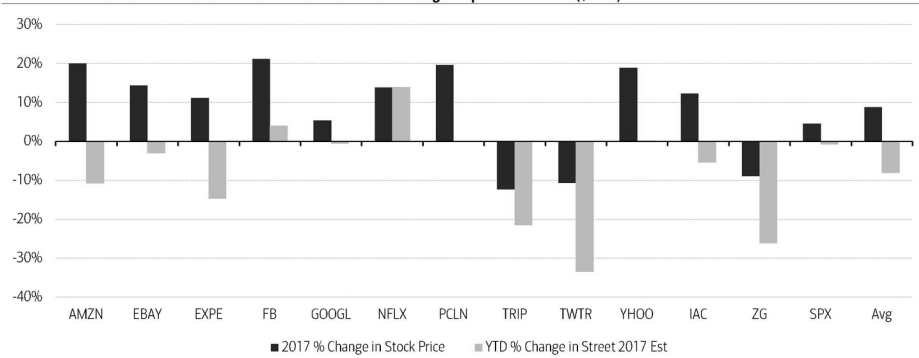
Chart 1: YTD Stock Price Performance vs. YTD 2017 Estimate Revisions By Sector



Source: Excludes companies with negative earnings, Bloomberg, as of 4/4/2017

Nine of the twelve large caps in our group are up YTD and four of these companies have had positive stock returns despite negative EPS estimate revision (AMZN, EXPE, EBAY & IAC). TRIP is the worst performing large cap YTD, down 12%. Only FB and NFLX have had positive 2017 EPS estimate revisions, with GOOGL, YHOO and PCLN holding flat.

Chart 2: YTD Stock Price Performance vs. YTD 2017 EPS Revisions For Larger-Cap Internet Stocks ($5bn+)



Source: Bloomberg consensus estimates, as of 4/4/2017

HOUSE_OVERSIGHT_014891

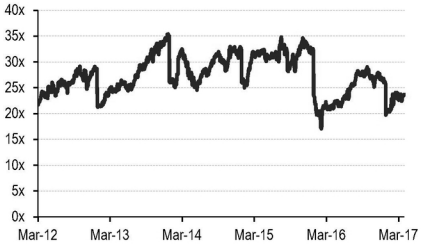
Sector Valuations

Internet sector trading multiples for EV/EBITDA and P/E are tracking up slightly YTD, (excluding NFLX). On a y/y basis, the group P/E is at 24x vs. 22x last year, while the group EV/EBITDA is at 14x vs. 13x a year ago.

Chart 3: Internet Sector Historical 2-Yr Forward Avg. EV/EBITDA

Source: BofA Merrill Lynch Global Research, Bloomberg, as of 4/4/2017

Chart 4: Internet Sector Historical 2-Yr Forward Avg. P/E



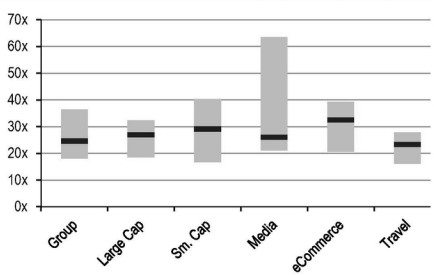
Source: BofA Merrill Lynch Global Research, Bloomberg, as of 4/4/2017

Large cap receiving a premium; Small caps at the low-end of historical range

Excluding NFLX and YHOO, large cap stocks in the Internet group are trading at 26x 2018 EPS below the small cap group at 28x 2018 EPS, with both Large and Small caps trading slightly above their average for the past 5 years (see chart below). The media sector is trading at a steep discount to travel and eCommerce.

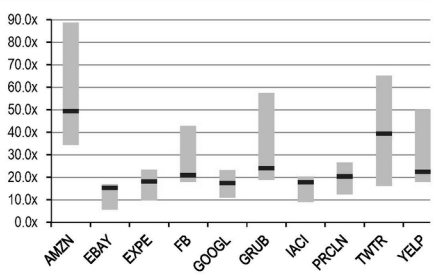
- The eCommerce sector is currently trading slightly above the midpoint of its five year range at 32x 2018 EPS. AMZN and WIX are well above at 49.5x and 74x respectively while EBAY is trading below at 15x.
- The Media sector is trading well below the midpoint of its recent range (excluding NFLX), at 25x 2018 EPS. GOOG (18x), FB (21x), and YELP (23x) are below the sector average while TWTR (40x) is above.
- The Online Travel sector is currently trading slightly above the mid-point of its five year range at 23x but below the internet sector average. TRIP (29x) is trading above the average while EXPE (18x) and PCLN (21x) are below.

Chart 5: Historical 2-Year Forward P/E Multiple By Sector (ex NFLX)



Source: BofA Merrill Lynch Global Research, Bloomberg, as of 4/4/2017

Chart 6: Historical 2-Year Forward P/E Multiple (select stocks)



Source: BofA Merrill Lynch Global Research, Bloomberg, as of 4/4/2017

HOUSE_OVERSIGHT_014892

Currency still a slight headwind for 1Q results but improving

We expect FX to remain a y/y headwind for 1Q results; the Euro is down about 6% y/y but up 1% from where it was when most Large-cap internet companies reported 4Q results in late January (~$1.06). The GBP at $1.22 is down slightly (1.4%) over the same period. Our currency strategist is forecasting the Euro to end 2017 at $1.05 and the GBP to end at $1.19. FX pressure will ease after 1Q if rates hold, unless a company has high exposure to Japan.

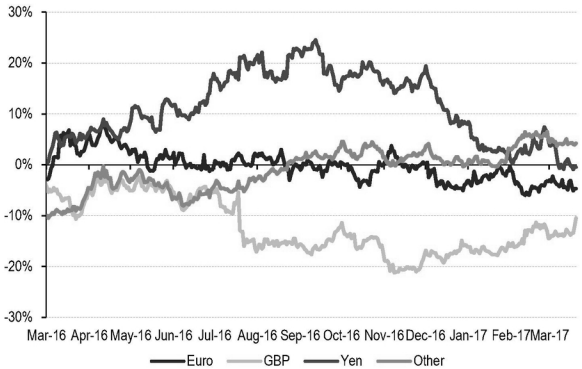
Table 5: Percent change y/y

	Euro	GBP	Yen	Other*
4Q15	-12.3%	-4.5%	-8.1%	-14.4%
1Q16	-2.0%	-5.4%	1.1%	-11.0%
2Q16	2.0%	-4.9%	9.4%	-6.3%
3Q16	0.3%	-13.9%	19.3%	-2.9%
4Q16	-1.5%	-17.4%	15.1%	0.0%
1Q17	-3.5%	-14.5%	2.5%	3.3%
2Q17E	-5.6%	-15.4%	-3.9%	-0.3%
3Q17E	-4.5%	-9.2%	-9.9%	-0.9%
4Q17E	-1.2%	-3.5%	-8.1%	0.2%

Source: BofA Merrill Lynch Global Research, Bloomberg, as of 4/4/2017

International revenues a percent of total revenues is highest at PCLN (87% of gross profit), GOOG (53%), FB (53%), TRIP (43%), EBAY (57%), and EXPE (42%). Higher operating margins in UK/Europe than US and lower Intl. taxes can increase this exposure.

Chart 7: Spot Rate % Change Y/Y (USD vs. FX Spot Rate)



Source: Bloomberg; Other Includes the following *Asian (KRW, AUD, HKD), Europe (RUB, SEK, CHF), Americas (BRL, MXN, CAD) , as of 4/4/2017

HOUSE_OVERSIGHT_014893

Sentiment Ranking Update

We are updating our sentiment ranking index on 25 stocks in our Internet coverage universe (as of 4/4/17). We have aggregated six different indicators we think are relevant to gauge sentiment and have generated an overall "sentiment" score for each company. This sentiment analysis is intended to be informative and should not be used to form an investment opinion; for example our model does not factor in valuation or management quality. Of our company coverage universe, we have excluded four game publisher companies as well as two recent IPO's from this analysis as data may not be comparable.

Table 6: 1Q16 change in sentiment ranking

Ticker	Rank	Pre 4Q Δ	Score	Pre4Q Δ
FB	1	+3	4	+4
WIX	2	-1	4	+2
TREE	3	-1	8	-1
AMZN	4	+5	8	+4
NFLX	5	-2	9	-1
GOOGL	6	NA	9	+1
PCLN	7	+1	9	+2
CRCM	8	+9	11	+3
EXPE	9	+5	12	+2
IAC	10	+5	12	+2
RATE	11	-4	13	-2
EBAY	12	+4	13	+1
ONDK	13	+5	14	+1
ZG	14	-9	14	-5
YHOO	15	+6	14	+3
GPRO	16	+8	14	+5
YELP	17	-7	16	-4
W	18	-5	16	-3
P	19	NA	16	NA
GRUB	20	-9	16	-4
MTCH	21	+1	17	+1
QUOT	22	-10	17	-4
FIT	23	+2	19	+1
TRIP	24	-1	20	-2
TWTR	25	-5	21	-5

Source: BofA Merrill Lynch Global Research, Bloomberg, as of 4/4/2017

Investor sentiment categories

We assembled data that measures investor sentiment across six categories. These metrics include latest short interest (as a % of float), change in short interest as a % of float over the last 90 days, current stock performance over the last 90 days, current average sell side ratings, forward year EPS estimate revisions over last 90 days, and expected FY17 revenue growth. While there are no perfect indicators of average investor sentiment, we believe these metrics provide a helpful framework of investor sentiment in our sector. In our analysis, Facebook, WIX, and LendingTree had the highest sentiment in 1Q, while Fitbit, Trip and Twitter had the lowest sentiment. Care.com had the most improved ranking, moving up 9 points to 8th, while Quotient had the biggest decline moving down 10 spots in our ranking to 22nd.

Methodology

Our methodology consisted of: 1) gathering financial data across six categories that we believe are relevant to measuring investor sentiment, 2) ranking companies on each attribute using a scale of 1 to 29, with 1 highest and 29 the lowest, and 3) ranking the companies based on the avg. score of the six metrics.

HOUSE_OVERSIGHT_014894

Highest sentiment: FB, WIX, and TREE; Lowest: FIT, TRIP, and TWTR

Based on our sentiment ranking index, Facebook, Wix, and LendingTree have top investor sentiment pre 1Q earnings. Facebook moved into first place from fourth due to the lowest short interest as % of float, second highest FY17 revenue growth, sixth highest sell side FY16 EPS estimate revisions, and third best stock performance in the last 90 days. Wix came in second place with top stock performance in the last 90 days, top expected FY17 revenue growth and second best sell-side FY16 EPS estimate revision, despite ranking ninth for current sell side ranking and seventh for short interest ratio. LendingTree placed third with best current sell side ranking and best change in short interest ratio.

Fitbit had third worst investor sentiment with the worst stock performance in the last 90 days, the worst expected FY17 revenue growth and the second largest change in short interest in the period. TripAdvisor, had the second lowest sentiment with the third worst sell side ranking and fifth worst sell side EPS estimate revision. Twitter, our lowest sentiment stock pre 1Q earnings, had second to worst sell side ranking and expected FY17 revenue growth, along with third to worst sell side estimate revisions and was below average in all of our categories.

Score Ranking vs. Investment Rating

Our sentiment analysis is independent of our investment rating system, and our investment rating may or may not factor in positive or negative sentiment. This scorecard analysis includes only data currently up to the last 90 days, and our investment rating opinion takes into consideration potential stock price fluctuations, attractiveness for investment relative to other stocks within our Coverage Cluster, business model quality, and valuation. Please see our Fundamental Equity Rating Opinion Key at the end of the report for more details.

Table 7: Combined Metric List

Company	Short Interest % float	Δ short interest % of float	Performance 90 days	Sell Side Ranking	EPS Estimate Revisions	Expected FY17 Rev. Growth
FB	1%	0%	21%	4.7	4%	37%
WIX	2%	-1%	67%	4.4	62%	43%
TREE	23%	-20%	21%	5.0	-6%	34%
AMZN	1%	0%	20%	4.8	-10%	21%
NFLX	6%	-1%	14%	4.1	15%	27%
GOOGL	1%	0%	6%	4.7	0%	19%
PCLN	3%	0%	20%	4.6	0%	16%
CRCM	3%	0%	42%	3.5	28%	6%
EXPE	8%	-2%	11%	4.6	-12%	14%
IAC	1%	0%	12%	4.4	-5%	-1%
RATE	2%	0%	-13%	4.2	2%	16%
EBAY	2%	0%	14%	3.6	-3%	5%
ONDK	12%	3%	1%	3.3	34%	30%
ZG	11%	-2%	-9%	3.9	-26%	24%
YHOO	6%	1%	19%	3.8	0%	2%
GPRO	36%	-3%	-4%	2.3	74%	7%
YELP	10%	0%	-14%	3.7	-2%	25%
W	38%	2%	17%	3.9	-22%	25%
P	30%	2%	-7%	3.9	2%	17%
GRUB	18%	7%	-11%	4.1	-5%	31%
MTCH	27%	5%	-4%	4.2	1%	8%
QUOT	8%	0%	-13%	4.8	-56%	5%
FIT	26%	-4%	-29%	3.1	NA	-27%
TRIP	16%	5%	-12%	2.9	-21%	11%
TWTR	11%	3%	-11%	2.5	-55%	-7%

Source: BofA Merrill Lynch Global Research, Bloomberg, as of 4/4/2017

HOUSE_OVERSIGHT_014895

Table 8: Combined metric rankings

Company	Short Interest % float	Δ short interest % of float	Performance 90 days	Sell Side Ranking	EPS Estimate Revisions	Expected FY17 Rev. Growth	Average
FB	1	8	3	4	6	2	4
WIX	7	6	1	9	2	1	4
TREE	20	1	4	1	17	3	8
AMZN	4	9	5	2	18	10	8
NFLX	10	7	10	13	5	6	9
GOOGL	2	12	13	5	12	11	9
PCLN	8	11	6	7	10	14	9
CRCM	9	14	2	20	4	19	11
EXPE	12	5	12	6	19	15	12
IAC	3	10	11	8	16	23	12
RATE	6	15	23	10	8	13	13
EBAY	5	13	9	19	14	20	13
ONDK	17	21	14	21	3	5	14
ZG	15	4	18	14	22	9	14
YHOO	11	18	7	17	11	22	14
GPRO	24	3	15	25	1	18	14
YELP	14	16	24	18	13	8	16
W	25	19	8	15	21	7	16
P	23	20	17	16	7	12	16
GRUB	19	25	20	12	15	4	16
MTCH	22	24	16	11	9	17	17
QUOT	13	17	22	3	24	21	17
FIT	21	2	25	22	N/A	25	19
TRIP	18	23	21	23	20	16	20
TWTR	16	22	19	24	23	24	21

Source: BofA Merrill Lynch Global Research, Bloomberg, as of 4/4/2017

HOUSE_OVERSIGHT_014896

Alphabet (Buy, $1,025 PO)

Stock view: Expect solid 1Q revs., but loss of non-GAAP reconciliation a concern
New concerns have been raised on the YouTube advertiser pullback, but with the cuts in spending surfacing primarily in the back half of March, we anticipate only modest impact to 1Q revenue, with more significant potential impact to 2Q17 (see Advertiser boycott raising concerns on 1Q/2Q revenues). Looking beyond the YouTube issues, our early 1Q ad checks were mostly positive, with Merkle highlighting modest revenue growth acceleration, better than the 70bps of ex-FX Website revenue deceleration in 1Q17 (vs 4Q16) we've assumed in our model. Overall, we expect in-line to slightly better 1Q results driven by mobile and PLA strength (and perhaps some maps ads), but see risk of moderate Street estimate cuts for 2Q/3Q revenue on YouTube concerns. For most companies, we would expect management to help clear up the advertiser controversy on the call with some added financial disclosure or guidance, but predicting what Alphabet will say on the topic is more difficult.

1Q results will be the first quarter that Google reports GAAP EPS without a non-GAAP EPS reconciliation. With higher than usual SBC in 1Q due to changes in grant timing, it is possible Google misses Street GAAP EPS. We are leaving our revenue unchanged but lowering GAAP EPS to $7.26 from $7.36 based on higher SBC. Also, unusual charges are more likely to be controversial for Google without a non-GAAP EPS reconciliation.

Core margins remain a key focus, as has been the case since 3Q16 when core Google non-GAAP operating margins contracted 95bps y/y. We expect core margins to remain down y/y driven primarily by segment mix, and our model assumes 2017 core margins are down 50bps in 2017 (to 46.1%) and another 20bps in 2018 (to 45.9%). For 1Q17, we assume 45.8% core Google non-GAAP operating margin, up 30bps q/q and down 75bps y/y. Our recent deep dive analysis suggests segment mix alone drives a natural 220bps margin headwind, which we think can be partially offset with 1) upside in high margin search growth from monetization growth (clicks and pricing); 2) leverage in individual segments from scale; and 3) cost cutting measures across the business (see Digging into the Alphabet revenue mix and margin drivers).

We continue to like the stock, but recognize that potential estimate trimming on YouTube concerns, further margin contraction, SBC pressure on GAAP EPS and challenging 2Q17 comps could continue to drag on near-term sentiment. Looking ahead, we are optimistic on 2H17 based on the potential for new ad format ramps, easing comps, and potential YouTube relief (we assume the advertiser boycott eases exiting 2Q). Alphabet trades at 22x GAAP (17x ex-Other Bets, cash), in-line with the S&P and in-line to below the 5-year average (23.5x), which we view as attractive.

Key theme/metric(s) for 1Q: Website growth, core margins
We believe the key metrics for the quarter will be ex-FX Website growth and core margins. For ex-FX website growth, we currently model 70bps of deceleration in 1Q17 (vs 4Q16), and we think deceleration could persist through 2Q17, after which the y/y growth comps ease considerably.

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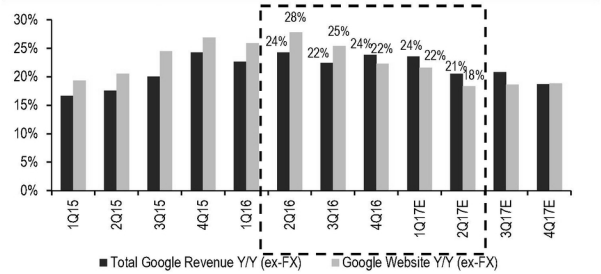
Chart 8: Google ex-FX Y/Y growth trends



Source: Company reports, BofA Merrill Lynch Global Research

For core margins, we assume y/y contraction through 3Q17, after which we model a slight uptick in 4Q17. For the year, we assume core Google margins contract 50bps to 46.1%. In terms of blended Alphabet non-GAAP operating margins, we assume 70bps of y/y contraction to 40.7% in 2017, but won't be surprised if better cost discipline (particularly in Other Bets) drives more stable y/y trends.

Table 9: Core Google non-GAAP operating margin forecast

	1Q16	2Q16	3Q16	4Q16	1Q17E	2Q17E	3Q17E	4Q17E	1Q18E	2Q18E	3Q18E	4Q18E
Core Google non-GAAP operating margin	46.5%	47.9%	46.5%	45.5%	45.8%	46.5%	45.6%	46.4%	45.6%	46.5%	45.4%	46.3%
Y/Y Change	1.4%	1.6%	-1.0%	-1.5%	-0.7%	-1.4%	-0.9%	0.9%	-0.2%	-0.1%	-0.2%	-0.1%

Source: Company, BofA Merrill Lynch Global Research

Biggest 1Q issues/risks:

- **Deceleration in Google Website revenue:** There could be modest revenue pressure due to YouTube boycott impact, and/or ad shift to Facebook. One SEM suggested a modest uptick in advertising spend on maps, which could be a positive in 2017.

- **TAC to distribution partners:** Rising TAC rate (Apple, Samsung) could mitigate potential gross revenue upside in the higher margin mobile search segment.

- **Growth investments could drag on margins:** Investments in Google Cloud, hardware, and YouTube could be higher than we expect, which could negatively impact core Google margins and raise concerns on long-term sustainable margin levels.

- **YouTube/Display Network commentary:** While we do not expect full resolution on the YouTube/Display Network issues, management's tone will likely impact expectations for timing of a fix, corresponding costs, magnitude of the boycott losses, and time to recover lost ad spend.

- **Stock comp timing shift could cause some GAAP lumpiness:** Shift in timing of annual stock-based comp grants could impact 1Q EPS, but should be offset with lower relative cost in 2H17.

Top 1Q data point:

Our early 1Q checks (pre quarter end) have been mostly positive, but most checks did not contemplate a potential impact of the YouTube & Display Network pullback. ComScore PC click data has suggested Google PC queries are down 3% q/q QTD, slightly worse than the 2% q/q decline in 1Q16.

HOUSE_OVERSIGHT_014898

Estimate vs Consensus

Our revenue and EBITDA estimates of $20.2bn/$9.9bn are slightly above the Street at $19.9bn/$9.8bn. Our model assumes currency to be a 2% headwind on y/y international revenue in 1Q17 (similar to 4Q16) and a 3% headwind in 2Q17. Our 1Q17 non-GAAP EPS of $9.53 is slightly above consensus at $9.45, and on a GAAP basis, our 1Q estimate for $7.26 is slightly below the Street at $7.42. For 2017, we are above on revenue, EBITDA, and non-GAAP EPS, but slightly below on GAAP EPS.

Table 10: Alphabet Estimate Summary

	1Q17	2Q17	2017	2018
Revenue				
BofA ML est.	$20,219	$21,009	$88,636	$104,228
Growth Y/Y%	*23%*	*20%*	*21%*	*18%*
Street	$19,891	$20,867	$87,691	$102,632
BofA ML vs Street	Above	Above	Above	Above
EBITDA				
BofA ML est.	$9,897	$10,428	$43,457	$50,670
Street	$9,788	$10,384	$43,264	$50,252
BofA ML vs Street	Above	Above	Above	Above
EPS				
BofA ML est.	$9.53	$10.02	$41.82	$48.45
Street	$9.45	$10.09	$41.12	$48.56
BofA ML vs Street	Above	Below	Above	Below
GAAP EPS				
BofA ML est.	$7.26	$7.75	$32.66	$37.81
Street	$7.42	$8.06	$33.31	$39.16
BofA ML vs Street	Below	Below	Below	Below

Source: BofA Merrill Lynch Global Research, Bloomberg, as of 4/4/2017

Given the recent YouTube & ad network concerns, it's possible stock sees a lift on in-line EPS if commentary on content fixes and advertiser pullback is constructive. We are comfortable with our $1,025 price objective, based on 21x core Google GAAP EPS plus cash. Our PO multiple is within the five year range of 12-24x forward P/E. Easing comps and potential new ad format ramps (Google's advertiser conference is May 23) could be positive 2H drivers.

HOUSE_OVERSIGHT_014899

Amazon (Buy, $1,100 PO)

Stock view: Positive on retail, but street increasingly focused on advertising
For Amazon's retail business, sentiment remains positive despite some modest 4Q revenue weakness vs expectations. We expect the retail business to remain strong in 1Q with stable growth as core drivers (Prime, delivery infrastructure advantage) remain intact. The lack of early tax refund support is a potential 1Q risk, but we would expect any delayed spending to bounce back in March or 2Q. Continued store closures by traditional retailers should aid the online shift throughout 2017. Finally, it appears Amazon has become stepped up advertising on its site, with more sponsored listings, which could be a source of revenue upside in 2017. Amazon had new revenue disclosures in its 10-K, and the ad revenue line significant accelerated in 2016.

For AWS, we expect some additional q/q revenue deceleration and q/q declines in margins. We note that AWS growth in 4Q was below our estimates, and the effects of 4Q's late price cuts should drive additional deceleration in 1Q. Microsoft and Google are well capitalized competitors that are significantly increasing cloud investment (see Battle in Seattle for industry update), so the Street sentiment could shift more cautiously on Amazon on a slight miss.

Margins continue to be a risk, but top line trends seem to be the biggest driver of sentiment and advertising optimism has grown. Amazon's current investment cycle began in earnest in 3Q'16, and we expect the elevated pace of investment to persist through 3Q'17. Margins may see y/y declines given: 1) Ongoing investments in fulfillment center build out (given fulfilled unit growth of 40% in 2016), 2) Digital content and related marketing, 3) Prime benefits (Now and Fresh), 4) Alexa/Echo, and 5) India. We think the Street is constructive on these initiatives, and will move past lower y/y margins concerns if top line growth is stable in 1Q.

Key theme/metric(s) for 1Q: AWS growth and 2Q profit outlook
We forecast 43% y/y AWS growth in 1Q, down from 47% in 4Q, partially due to the lingering effects of price cuts that went into effect on December 1st. This implies 4% q/q growth v. 9% last quarter. Increased investments in logistics/fulfilment, AWS, marketing, Prime content and others could set Amazon up for disappointing margin guidance vs. the Street's expectations. However, we think the Street will focus on revenue trends and ultimately view the investments as a long-term positives.

Biggest 1Q issues/risks:

- 2Q GAAP operating income outlook given increased investments in logistics, India, Prime Instant Video content, as well as expected AWS deceleration
- Gross profit growth trends given expense issues and tougher growth comps in 1H17
- AWS margin trends given AWS price cuts and aggressive competition
- International segment performance given investments in India

1Q traffic data points mixed
comScore's US data indicates that Amazon PC user growth has been down 2% y/y in 1Q through February vs. 4Q at -5% y/y. Mobile user growth is up 8% y/y vs. up 9% in 4Q. Amazon's total mobile and PC minutes were down 5% y/y in 1Q through February vs. up 18% y/y in 4Q; mobile minutes were down 7% y/y in 1Q vs. +18% y/y in 4Q.

1Q items/news:

- **Logistics investments:** Amazon announced a $1.5bn air hub in Northern Kentucky that will host Amazon's own cargo airline.
- **AWS outage:** AWS had a large outage in early March. Investors will likely focus on the competitive implications of the outage.

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- **Walmart continuing to acquire eCommerce assets and launching free 2-day shipping**: Investors will likely focus on Amazon's results relative to Wal-mart.

- **Amazon Business:** Amazon Business announced a multi-year agreement with a public sector co-op, worth $500mn/year with a 5 year contract and 6 option years (see Now we're in Business: Amazon announces new B2B contract with public sector co-op).

- **Prime Now expansion:** Prime Now launched 1-hour delivery in Milwaukee and Boston during the quarter. Amazon also launched the ability for Alexa users to make Prime Now orders.

- **Upcoming 2Q events:** AWS Summit SF (April 18-19), new Prime Instant Video content rollout (*Manchester by the Sea*, Bosch season 3, I Love Dick).

- **Souq.com acquisition:** Amazon has an agreement to acquire Souq.com, the leading eCommerce platform in the Middle East. Terms were not disclosed, though press reports indicate that Amazon had bid $650mn for the company before Emaar Malls made a public bid of $800mn. The deal is expected to close in 2017.

- **Physical store rollout:** Amazon has launched or planned to open 10 AmazonBooks stores, is beta testing its AmazonGo grocery store concept (though public opening was delayed due to technology issues), and there are press reports that Amazon is testing other grocery store formats as well.

- **Google Cloud Conference:** No significant price announcements were made, but Google's conference was much more impressive this year (see What a difference a year makes for Google Cloud).

Souq.com brings Amazon into the Middle East

Amazon announced that it has an agreement to acquire Souq.com, the leading eCommerce platform in the Middle East. Terms were not disclosed, though press reports indicate that Amazon had bid $650mn for the company before Emaar Malls made a public bid of $800mn. This will represent Amazon's largest deal since the $970mn Twitch acquisition in 2014.

Souq.com does not disclose its sales or earnings, making it difficult to assess the acquisition multiple or potential accretion of the deal. An $800mn acquisition implies 0.2% of Amazon's current market cap. Though it is somewhat surprising for Amazon to acquire a company in order to enter a new market, Amazon can leverage logistics, sourcing, customer, and technology investments at Souq.com. The deal is expected to close in 2017. Souq.com offers 8.4mn products across 31 categories, including electronics, health & beauty, fashion, home goods, and baby. The site has 45mn monthly visitors and localized operations in Saudi Arabia, UAE, and Egypt and localized sites for the UAE, Egypt, Saudi Arabia, Kuwait, Bahrain, Oman, and Qatar. Euromonitor estimates that Middle East & Africa GMV is $9bn market in 2016 though other reports peg the market at $20bn, implying roughly 1-2% eCommerce penetration in the region vs. mid-teens in Western markets. Press reports last year indicated that Amazon was exploring entering Australia and Singapore in 2017. The Souq.com acquisition may signal a more aggressive global expansion plan.

Estimates vs. Consensus: Above Street revenue and EPS

We expect 1Q revenue/EPS of $35.3bn/$2.34 vs. Street at $35.3bn/$2.28. Amazon's 1Q revenue guidance is $33.25-35.75 and GAAP operating income of $250-900 (we are at $898mn in operating income). Our 1Q revenue estimate of $35.3bn (+21% y/y vs. 22% in 4Q16) is based on 24% y/y unit growth vs. 24% y/y in 4Q. For 1Q17, we estimate -19% q/q revenue growth vs -19% q/q in 1Q last year. We are below the street for 2Q margins.

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Table 11: Amazon Estimate Summary

	1Q17	2Q17	2017	2018
Revenue				
BofAML est.	$35,335	$36,784	$164,532	$194,826
Growth Y/Y%	*21%*	*21%*	*21%*	*18%*
Street	$35,255	$36,815	$165,158	$199,387
BofAML vs. Street	Above	Below	Below	Below
EBITDA				
BofAML est.	$4,153	$4,626	$18,246	$22,022
Street	$4,085	$4,835	$19,382	$24,850
BofAML vs. Street	Above	Below	Below	Below
EPS				
BofAML est.	$2.34	$2.86	$10.90	$14.37
Street	$2.28	$3.30	$12.60	$18.16
BofAML vs. Street	Above	Below	Below	Below

Source: BofA Merrill Lynch Global Research estimates, Bloomberg, as of 4/4/2017

Our PO of $1,100 is based on our SOP that values AWS at $127bn or $259 per share and the retail business at $413bn or $841 per share. Our 5.5x AWS multiple is a modest premium to the software/SaaS comp group at 5.0x on 2018 sales, and 0.9x multiple is a premium to a retail general merchandise comp group at 0.7x. We think the premiums are warranted given share gains and superior growth. Our $1,100 price objective implies 2.8x 2018E Price/Sales, a multiple above the high end of Amazon's historical range of 1.0-2.5x. We argue the historical P/S multiple should increase given positive 3rd party sales (3P) that is reported on a net basis, a higher AWS revenue contribution, an increasing advertising contribution, and record gross profit margins.

HOUSE_OVERSIGHT_014902

eBay (Buy, $38 PO)

Stock view: Marketplace growth should improve in 2017

eBay's 4Q results showed signs of Marketplace improvement, with improving mobile and C2C trends and a modest pickup in new buyers. Management expects to put marketing dollars behind this trend to drive Marketplace growth momentum in 2017 (guidance calls for 1 point of acceleration in Marketplace volume in 1Q, with 2 points for the full year). Expectations have risen since the start of the year, and we think eBay needs to deliver 1 point acceleration in US GMV growth vs 1Q to maintain confidence in management's execution. There is also significant interest in eBay's first party ad strategy and potential improvement in transaction take rates (at expense of MS&O revenues).

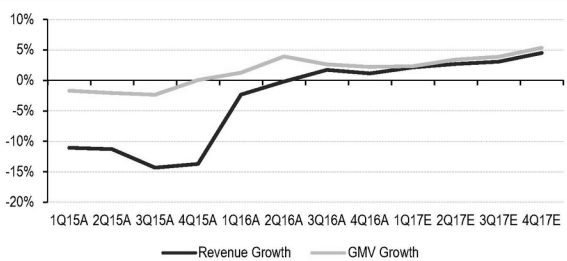
The potential structured data impact also remains top of mind for investors as structured data will provide the backbone for improving customer search and product experiences. As of 4Q'16, there are 180mn+ structured data pages v. 100mn+ pages at the end of 3Q'16. More pages are expected in 2017, which will start to be exposed to core organic traffic. Management appears confident that the impact of structured data would increasingly benefit results and that structured data formats will be much more visible by holiday 2017. Overall, if 1Q results are at/above expectations, we think the stock will reflect even more optimism on structured data improvement.

For margins, we expect continued pressure in 2017 as the company ramps up marketing spend and increases its AI capabilities. If the company can manage to accelerate top line growth through conversion rate improvements, some of the upside may be invested, limiting 2017 earnings flow through (but benefitting growth in 2018). Therefore, we think customer, transaction and revenue trends most important for 2017, but lack of margin flow through could be sentiment headwind for the stock.

Key theme/metric(s) for 1Q: Marketplace growth/outlook

Our model assumes US GMV growth of 3.5% y/y, an 80bps q/q acceleration off an 80ps easier y/y comp, while we anticipate 6.0% y/y Intl ex-FX GMV growth. US acceleration (despite a modest Leap Year headwind) is likely needed to maintain increased management confidence. Our model assumes 8.3% take rate, which is up 10bps y/y and could be aided by the early transition to 1st party advertising on the site. eBay's 1Q revenue guide implies 5% y/y ex-FX growth at the midpoint, while the 2017 revenue guide calls for 7% ex-FX growth, implying revenue growth acceleration during the year.

Chart 9: eBay quarterly GMV and revenue y/y growth



Source: BofA Merrill Lynch Global Research estimates, company report

Biggest 1Q issues/risks:

- Overall GMV growth remains muted as structured data changes still early, reducing confidence in future improvement.

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- StubHub trends as StubHub GMV comps are tough in 1H'17 (32% y/y growth in 1H'16).

- Marketing expenses are expected to increase, putting pressure on margins and could raise concerns that GMV growth is being "bought".

Early 1Q traffic data points mixed

comScore's eBay desktop unique visitors decreased 6% on average through February vs. down 2% in 4Q. comScore's total eBay mobile and PC minutes declined 20% y/y on average through February in 1Q vs. down 17% y/y in 4Q. comScore indicates mobile minutes decreased 38% vs. down 20% in 4Q.

Estimates vs. Consensus: Expect modest EPS upside

We expect eBay to report broadly in-line revenue/EPS estimates of $2.21bn/$0.49 vs. the Street at $2.21bn/$0.48 (guidance is $2.17bn-$2.21bn and $0.46-$0.48). Our model assumes 11mn shares repurchased in 1Q (about $350mn of repurchase activity). We have adjusted our GAAP EPS for higher amortization of deferred tax asset.

Table 12: eBay Earnings Summary

	1Q17	2Q17	2017	2018
Revenue				
BofAML est.	$2,210	$2,340	$9,458	$10,062
Growth Y/Y%	*3%*	*5%*	*5%*	*6%*
Street	$2,206	$2,315	$9,398	$9,925
BofAML vs. Street	Above	Above	Above	Above
EBITDA				
BofAML est.	$855	$843	$3,520	$3,735
Street	$841	$827	$3,494	$3,726
BofAML vs. Street	Above	Above	Above	Above
EPS				
BofAML est.	$0.49	$0.48	$2.03	$2.22
Street	$0.48	$0.47	$2.01	$2.21
BofAML vs. Street	Above	Above	Above	Above

Source: BofA Merrill Lynch Global Research estimates, Bloomberg, as of 4/4/2017

Our $38 price objective is based on 17x our 2018E non-GAAP EPS. O ur 17x P/E multiple is slightly ahead of the retail comp group average of about 16x, reflecting eBay's potential for a Marketplace growth acceleration (to well above average retail growth) in 2017. With 6-8% growth and an 8% FCF yield, we think eBay remains an interesting value stock for retail investors, although GARP focused Internet investors may prefer stronger growth at Google or Priceline.

HOUSE_OVERSIGHT_014904

Expedia (Buy, $146 PO)

Stock view: 1Q faces tough comps, but should clear way for strength into '18
We think 1Q expectations are somewhat muted as Expedia has highlighted several earnings headwinds in early 2017, including incremental cloud migration spend, higher marketing spend and, recently, potential ADR pressure. 1Q'17 earnings will face the toughest room night growth comps, though Expedia expressed optimism on trends through January on the 4Q call. Comps ease during the rest of the year for Expedia, which we see as a positive set up for the stock. We think Expedia will reiterate its 10-15% EBITDA growth outlook and .Expedia remains our top 2017 summer (2Q/3Q) travel idea.

We currently forecast 20% y/y room night growth in 2Q/3Q, though the comp is 1600bps easier vs. 1Q and street growth expectations could be higher. The ongoing benefit of conversion rate improvements, the Easter shift into 2Q (noted as 1% impact in 2Q'16), as well as the benefit of more aggressive marketing spend should aid 2Q growth. Additionally, prior to 1Q'17 earnings, Expedia will begin to disclose HomeAway online bookings and room nights, which we think may drive y/y room night growth 200-300bps higher (we forecast HomeAway room nights up 50% y/y in 2017 vs. core OTA room nights up 18%). We think investors will also view HomeAway disclosure positively if the data indicates that the HomeAway transition remains on track and provide visibility into potential EBITDA acceleration in 2018.

STR data suggests hotel fundamentals deteriorated modestly in the US through initial March readings, but improved slightly in Europe through February. However, Expedia's CEO commented in a recent interview with the *Financial Times* that international tourism to the US (Expedia's key market) has decelerated following the introduction of Trump's travel bans, which may be a downside risk to 1Q bookings and revenues. This mirrors ForwardKeys data from early March that after Trump's executive order, foreign tourism bookings to the US fell, then rebounded when the ban was suspended, but declined again when the ban was re-introduced. A few US hotel operators have indicated little impact from travel bans, so data is mixed.

Key theme/metric(s) for 1Q: room night growth vs industry and Priceline
We expect 1Q organic room night growth to remain steady at 16% y/y, though we note that this does not yet include the contribution from HomeAway, which we think should add 200-300bps to y/y growth. We expect N. America bookings growth of 12% y/y vs. 8% in 4Q, Int'l bookings (FX-neut.) of 14% y/y.

Biggest 1Q issues/risks:

- Room nights may disappoint on tougher 1Q comps, negatively impacting the acceleration thesis
- Expedia's CEO commented in a recent interview with the *Financial Times* that international tourism to the US (Expedia's key market) has decelerated following the introduction of Trump's travel bans, which may pressure hotel ADRs and be a downside risk to 1Q bookings
- Pace of investments, namely cloud IT spend ($110mn in 2017) and marketing ramp
- HomeAway EBITDA trends given marketing spend ramp and pressure on subscription revenues. Street has high expectations for the business.
- Pressure on hotel take rates given agency mix shift and rewards programs

Early 1Q RevPAR data decelerates
According to STR, 1Q US RevPAR through initial March readings decelerated 30bps to 3.0% y/y, and European RevPAR through February accelerated 600bps q/q to 3.6% y/y

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(FX-neutral). The STR data reflects a continued gradual deceleration in US RevPAR growth and a more recovery in European RevPAR growth as the region laps terrorist attacks and geopolitical uncertainty.

Table 13: US and European RevPAR Y/Y Change

US	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17**	1Q16	2Q16	3Q16	4Q16	1Q17
Occupancy	-0.3%	-0.8%	-0.4%	2.2%	-0.5%	0.3%	-1.0%	-0.4%	1.6%	-0.3%	2.5%	-0.1%	0.5%	-0.5%	1.6%	-0.5%	0.7%	0.1%	0.7%	0.5%
ADR	2.8%	3.6%	3.2%	2.8%	2.4%	3.5%	3.6%	2.5%	3.9%	1.9%	3.4%	2.4%	3.2%	1.7%	2.6%	3.2%	2.9%	3.3%	2.6%	2.5%
RevPAR	2.4%	2.8%	2.7%	5.0%	1.9%	3.8%	2.5%	2.1%	5.6%	1.6%	5.9%	2.3%	3.8%	1.2%	4.2%	2.7%	3.6%	3.4%	3.3%	3.0%
Europe																				
Occupancy	1.4%	1.5%	0.3%	3.5%	-0.3%	-0.7%	-0.4%	-1.5%	0.8%	-0.4%	4.2%	4.5%	5.1%	2.9%		1.1%	0.8%	-0.4%	2.8%	4.0%
ADR	-4.3%	-2.7%	2.5%	3.2%	0.3%	-4.5%	-0.7%	-4.8%	-1.8%	-8.6%	-5.3%	-5.0%	-2.1%	-3.1%		-1.5%	-0.3%	-2.4%	-6.3%	-2.6%
RevPAR	-2.9%	-1.3%	2.8%	6.8%	-0.1%	-5.1%	-1.1%	-6.2%	-1.0%	-9.0%	-1.3%	-0.7%	2.9%	-3.1%		-0.5%	0.5%	-2.8%	-3.7%	-0.1%
Europe in Euros	**Jan-16**	**Feb-16**	**Mar-16**	**Apr-16**	**May-16**	**Jun-16**	**Jul-16**	**Aug-16**	**Sep-16**	**Oct-16**	**Nov-16**	**Dec-16**	**Jan-17**	**Feb-17**		**1Q16**	**2Q16**	**3Q16**	**4Q16**	**1Q17**
Occupancy	1.4%	1.5%	0.3%	3.5%	-0.3%	-0.7%	-0.4%	-1.5%	0.8%	-0.4%	4.2%	4.5%	5.1%	2.9%		1.1%	0.8%	-0.4%	2.8%	4.0%
ADR	0.0%	-0.2%	-1.7%	-0.1%	-0.9%	-4.4%	-2.7%	-4.6%	-1.6%	-8.5%	-5.4%	-1.5%	-0.9%	0.2%		-0.7%	-1.8%	-3.0%	-5.2%	-0.4%
RevPAR	1.4%	1.2%	-1.4%	3.3%	-1.2%	-5.0%	-3.1%	-6.0%	-0.9%	-8.9%	-1.4%	2.9%	4.2%	3.0%		0.4%	-1.0%	-3.3%	-2.4%	3.6%

Source: Smith Travel Research (STR), BofA Merrill Lynch Global Research estimates; Note: **March data is month to date

Estimates vs. Consensus: In-line 1Q revenue and EPS

We expect 1Q revenue/EPS of $2.13bn/$0.07 vs. the Street at $2.14bn/$0.06 driven by 8% core OTA growth, 48% Trivago growth (in USD), 2% Egencia growth, and 16% HomeAway growth. We expect room night growth to remain stable at 16% in 1Q'17 before accelerating on easier comps in 2Q/3Q. Expedia guided 2017 EBITDA growth to 10-15% and our 2017 EBITDA forecast of $1.86bn (15% y/y growth) is modestly above the Street at $1.83bn (14% y/y growth).

Table 14: Expedia Estimate Summary

	1Q17	2Q17	2017	2018	2019
Revenue					
BofAML est.	$2,134	$2,555	$10,097	$11,424	$12,931
Growth Y/Y%	*12%*	*16%*	*15%*	*13%*	*13%*
Street	$2,140	$2,507	$10,010	$11,266	$12,429
BofAML est. vs. Street	Below	Above	Above	Above	Above
EBITDA					
BofAML est.	$182	$379	$1,857	$2,141	$2,416
Street	$179	$367	$1,835	$2,212	$2,628
BofAML est. vs. Street	Above	Above	Above	Below	Below
EPS					
BofAML est.	$0.07	$0.99	$5.54	$6.84	$7.71
Street	$0.06	$0.94	$5.38	$6.88	$8.55
BofAML est. vs. Street	Above	Above	Above	Below	Below

Source: BofA Merrill Lynch Global Research estimates, Bloomberg, as of 4/4/2017

Our $146 price objective is based on our sum of the parts (SOP) that assumes 9x 2018E EBITDA for the core OTA business (a discount to Priceline at approx. 15x due to slower organic growth and higher taxes on earnings), 8x 2018E EBITDA for Egencia (we expect single digit growth), 60% ownership of Trivago (using our PO), and 15x 2018 EV/EBITDA for HomeAway, plus net cash and long term investments.

HOUSE_OVERSIGHT_014906

Facebook (Buy, $165 PO)

Stock view: Becoming the one-stop social shop

We expect Facebook to report upside to Street 1Q revenue (but less in absolute dollars than in 4Q) driven by robust demand, Instagram momentum, and solid underlying user growth and engagement. Early ad checks in the quarter indicate steady advertiser trends, with some elements of seasonality off a stronger 4Q, and strength at Instagram. We expect pricing tailwinds to begin to pick up as we approach ad inventory supply moderation in 2H17, and a flurry of new product introductions could provide additional sources of ad load inventory over time. Overall, we see 1Q as an in-line to slightly better quarter, and are optimistic on the set-up for the remainder of the year for pricing, expense management, user engagement, and new platforms/feature ramps. Facebook will be hosting its F8 developer conference before earnings in San Jose on April 18-19.

Facebook had another busy quarter of new product launches with a notable trend of Snapchat-like features (Stories, Direct ephemeral messaging) and Video. At this point, we believe the Snap threat is less of a near-term concern. Recent key product/feature releases include:

- **Stories for all:** On the tail of a successful Instagram Stories launch in 8/16, Facebook rolled out WhatsApp Status (2/17), Messenger Day (3/17), and Facebook Stories (3/17).
- **Direct ephemeral messaging:** After introducing ephemeral direct photo/video sharing on Instagram in 11/16, Facebook announced a comparable feature with integrated filters/masks/frames for the core Facebook app in 3/17.
- **Video App for TV:** Announced in February, new app for Apple TV, Amazon Fire TV, and Samsung Smart TV to enable FB video viewing on TV.
- **New ad products:** Instagram Stories ads (1/17) a positive tailwind to Instagram ad load, while vertical video ads (Facebook 9/16, Instagram 11/16) and Collections (3/17) are likely positive for pricing.

While, in many ways, Facebook is duplicating Snapchat's innovation, we are encouraged with the rate of new product introductions and view the Facebook Stories and Direct ephemeral messaging (with filters/masks) as positives for user engagement and potential barriers to competitive risk. While management's focus in the near-term will likely be on new feature adoption, we expect Stories ads within 1-2 quarters and the company is already establishing partnerships for branded masks/filters (see More Stories in the Snap competitive saga). Over time, we would not be surprised to see filter/mask features and ads added to WhatsApp and, possibly, Messenger, which could unlock new monetization potential.

On the expense front, we continue to view management's 2017 expense growth forecast (47-57%) as conservative. History would seem to suggest manage could trim the top of the range on the 2Q earnings call, with more meaningful revisions in 2H17. That said, we won't be surprised if management maintains the outlook on the April call, particularly given the velocity of new feature launches and potential investments in video content.

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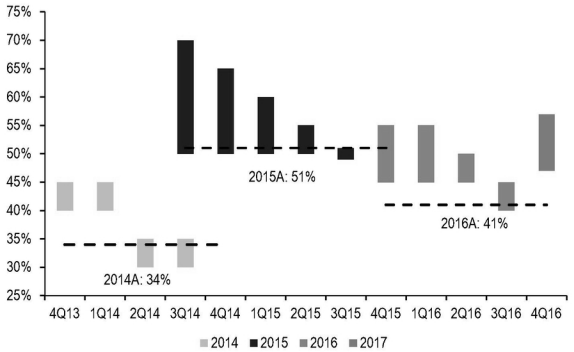
Chart 10: 2017 expense forecast now reflected in estimates; potential for favorable revisions ahead



Source: Company, BofA Merrill Lynch Global Research

Key theme/metric(s) for 1Q

Underlying MAU and DAU trends are still the key metrics for the stock, in our view. We assume MAUs grow 16% y/y to 1.91bn and DAUs 16% to 1.26bn, keeping DAU/MAU at a steady 66%. It's possible (but hard to predict) that management offers an update on Instagram users (600mn MAU, 400mn DAU in 4Q), and more specifically, Instagram Stories (150mn DAU in January). On the messaging front, there could be a Messenger user update (1bn as of 7/16), while a WhatsApp update is less likely (1.2bn as of 4Q16). We expect ad impressions to grow 46% y/y (49% in 4Q) and ad prices to increase 2% y/y (3% in 4Q).

Biggest 1Q issues/risks:

- **Expense trajectory or lack of an expense guidance change could disappoint:** While we continue to anticipate favorable revisions to management's 2017 expense forecast in 2H, near-term adjustments may be less likely given the velocity of new product launches and potential video content investments.

- **1Q ad revenue deceleration possible:** We note that 4Q was particularly strong and it's possible 1Q normalization could result in revenue growth deceleration.

- **Lack of commentary on monetization strategy:** While Messenger/WhatsApp monetization is likely still a 2018 story, lack of constructive commentary on timing could disappoint.

- **User deceleration always a risk:** MAU and DAU growth has surprised to the upside at mid-to-high teens y/y growth, and any meaningful slowdown could raise competitive concerns.

Top 1Q data point: Instagram reaches 1mn advertisers

Mid-quarter data points were somewhat limited in 1Q, though management did give an update on the Instagram monetization efforts. In a March 2017 update, management indicated that Instagram grew to 1mn advertisers, double the number since 9/16, with business profile pages up to 8mn from 5mn in 4Q. Facebook's comparable metrics are 4mn advertisers (as of 9/16) and 65mn business pages (4Q16).

For early advertiser checks, general feedback suggested positive trends, but more 'steady as it goes' than absolute blow out. The stronger 4Q was highlighted as a tough

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comp, but overall demand remains robust. Instagram feedback was notably positive, with many suggesting the demand is additive (not reallocation from core Facebook).

Estimates vs Consensus

Our 1Q17 and 2Q17 revenue and EBITDA estimates are ahead above the Street. We assume ~800bps of advertising growth deceleration in 3Q and another ~400bps in 4Q, and our 2017 estimates are also slightly above consensus. On that premise, we are comfortable that Street estimates sufficiently reflect potential impact of News Feed ad load deceleration in 2H17.

Table 15: Facebook Estimate Summary

	1Q17	2Q17	2017	2018
Revenue				
BofA ML est.	$7,905	$9,303	$38,546	$48,882
Growth Y/Y%	*47%*	*45%*	*39%*	*27%*
Street	$7,798	$8,993	$37,774	$48,103
BofA ML vs Street	Above	Above	Above	Above
EBITDA				
BofA ML est.	$4,886	$5,844	$24,358	$30,905
Street	$4,743	$5,638	$23,775	$30,409
BofA ML vs Street	Above	Above	Above	Above
EPS				
BofA ML est.	$1.14	$1.37	$5.67	$7.01
Street	$1.11	$1.30	$5.43	$6.75
BofA ML vs Street	Above	Above	Above	Above
GAAP EPS				
BofA ML est.	$0.94	$1.17	$4.86	$6.02
Street	$0.86	$1.06	$4.45	$5.76
BofA ML vs Street	Above	Above	Above	Above

Source: BofA Merrill Lynch Global Research estimates, Bloomberg, as of 4/4/2017

Our $165 price objective is based on 24x our non-GAAP 2018E EPS and 27x GAAP EPS, multiples equal to about 1x 2018E revenue growth, mostly in-line with its social and online media peers. Facebook is our top large cap idea for positive estimate revision potential in 2017.

HOUSE_OVERSIGHT_014909

GrubHub (Buy, $49 PO)

Stock view: Marketing ramp should drive diner growth re-acceleration
In recent quarters, GrubHub has been leveraging a series of recent investments, including expanded delivery, more restaurants on the platform, repositioned brand driving more effective advertising, and product optimization, which is driving higher conversion rates. We think GrubHub is well-positioned to continue to leverage these investments to drive growth in 2017 and beyond.

GrubHub's delivery business is reaching scale in more markets, and delivered gross food sales run-rate increased from $500mn in 3Q to nearly $600mn in 4Q (20% of '16 food sales). Delivered orders were 40% higher than in 3Q. We think delivery will continue to drive take rate higher and be EBITDA accretive by YE17 as efficiencies are gained.

Competition remains a key concern for investors and weighs on sentiment. However, we believe that GrubHub's user base is sticky and its repeat order rate (>90%) is defensible. In 2016, as UberEats, Amazon Prime Now, DoorDash, and Postmates invested in expansion, GrubHub's active diner growth and order growth remained solid. Google Trends indicates that over the past 12 months, though competitors have expanded to more cities in the US, GRUB remains the overwhelming leader in the market, with both of its core brands (GrubHub and Seamless) many times the size of any of its competitors.

GrubHub 1Q results may also face a modest growth headwind from warmer weather in key markets like NYC and Chicago. For context, in 4Q15, GrubHub called out warmer weather was a 200bps y/y order growth drag (~$2mn in revenue, $12.7mn in gross food sales). Warmer weather can impact order volume and new diner growth, though new diners can partially shift to 2Q. We forecast 26% y/y gross food sales and 36% y/y revenue growth in 1Q'17.

We think active diner growth will accelerate in 2017 as the company invests more heavily in marketing and it comps out against its "quality over quantity" marketing strategy started in 1Q16. Investors, however, should expect that accelerating active diner growth will be counterbalance by lower order frequency as newer diners to the system tend to order less frequently. At the same time, we expect take rate will continue to expand as the delivery business grows.

Key theme/metric(s) for 1Q: gross food sales growth
We forecast gross food sales growth in 1Q of 26%, a modest deceleration from 27% in 4Q (flat with 4Q less the 1% hit from the lack of Leap Day in 1Q17). Though we think there is likely upside to our forecast given a 500bps easier y/y comp in 1Q vs. 4Q. We expect 1Q active diner growth of 25%, Grubs per Diner decline of 3%, and average order size growth of 5%.

Biggest 1Q issues/risks:

- Despite positive Google Trends data and commentary from management, mounting competition eats away at GRUB's growth and take rate, driving diner acquisition costs higher.
- Warmer weather during 1Q, particularly in GrubHub's core NYC and Chicago markets, may be a headwind to growth.
- RDS (restaurant delivery service) investments weigh on earnings at a rate higher than the $3mn in EBITDA drag that we have in our model for 1Q'17.
- Site and conversion rate improvements turn out to be one-time in nature rather than an ongoing, longer-term focus for management.

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- Marketing expense expected to ramp in 2017, which can weigh on earnings, especially if gross food sales comes in weaker than anticipated.

Estimates vs. Consensus: Broadly in-line with consensus in 1Q'17

We expect 1Q revenue/EPS at $153mn/$0.25 vs. the Street at $153mn/$0.24 driven by gross food sales growth and an improving take rate.

Table 16: GrubHub Estimate Summary

	1Q17	2Q17	2017	2018
Revenue				
BofAML est.	$153	$159	$650	$815
Growth Y/Y%	*37%*	*33%*	*32%*	*25%*
Street	$153	$158	$645	$782
BofAML vs. Street	Below	Above	Above	Above
EBITDA				
BofAML est.	$41	$46	$184	$247
Street	$40	$46	$181	$225
BofAML vs. Street	Above	Below	Above	Above
EPS				
BofAML est.	$0.25	$0.29	$1.13	$1.55
Street	$0.24	$0.28	$1.10	$1.37
BofAML vs. Street	Above	Above	Above	Above

Source: BofA Merrill Lynch Global Research estimates, Bloomberg, as of 4/4/2017

Our PO is $49, based on 32x our 2018E P/E (vs. high growth internet at 31x). We believe GRUB warrants a premium to eCommerce peers due to the attractive margins of the core business and, relative to the overall small-cap sector, GRUB has more attractive margins and growth potential.

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Match.com (Buy, $21 PO)

Stock view: Positive on Tinder monetization growth on new products
Match has continued to build monetization on Tinder and we expect a more widely released Tinder Boost as well as international marketing spend to have a positive impact in 1Q17 results. The incremental revenue increase combined with Core enhancements should drive ARPU forward, though we are still cautious given Core's declining to flat growth and project 1Q17 at $.0.57 (-3% y/y).

Another issue on the horizon for Match group is the high ownership percentage of IAC. Based on our discussions with management, this is a known issue from both Match and IAC's perspective. The high degree of IAC ownership limits the float and has created a disproportionate short interest on the company to obtain higher exposure to IAC's core (ex-Match) properties. Our conversations suggest we can expect further discussion from management on ways forward in 2017, with the most likely outcome, in our view, a spin off IAC's Match ownership to IAC shareholders.

As Tinder expands, one concern we have is that its highly diverse user base could cause an overload of options and limit user's ability to find the type of matches they are looking for. An "elite" version of the app was recently launched called "Select" (per TechCrunch), highlighting the company's focus on making sure users are able to find suitable matches in different ways.

1Q17 should see international marketing spend on Tinder begin to pay off. We expect that paid member count (PMC) will continue to trend up driven by Tinder and other recent platforming initiatives helping to increase conversion on Core mobile and other sites like Plenty of Fish (PoF) and Meetic.

Key theme/metric(s) for 1Q: International PMC growth
Key for the quarter will be international PMC growth and we expect international to grow 25% y/y to 2.3mn and overall PMC growth to be up 17% y/y to 5.9mn as Tinder marketing outside of the US should start paying off. We are still cautious on ARPU and expect modest declines of 3% y/y, we believe there is still upside potential here driven by Tinder Boost, released in September 2016 and Core turnaround efforts. Key issues for the call will be PMC growth, Tinder monetization and Core improvements.

Biggest 1Q issues/risks:

- Decline in margins due to increased marketing of Tinder and Core improvement
- Drop in monetization as more consumers switch to mobile from PC.
- New investment initiatives drive down FY17 earnings projections.

Estimates vs. Consensus: Expect lower revenue, slight beat on profit
We are modeling rev/EBITDA of $293mn/$78.5mn below the Street due to impact of Princeton Review sell off but higher on EBITDA vs. the Street's $307mn/$77mn estimate. We estimate total PMCs of 5.9mn in 1Q and average revenue per users of $0.527 down 3% y/y due to lower monetizing Tinder plans. With the sale of Princeton review closing 3/31 and management moving any income to discontinued operations, we have removed all non-Dating revenue from our model and believe our treatment of these discontinued operations (totally excluded from our estimates) is the reason our estimates are currently below the street.

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Table 17: Match estimate summary

	1Q17	2Q17	2017	2018
Revenue				
BofA ML est.	$293	$315	$1,285	$1,484
Growth Y/Y%	*20%*	*20%*	*16%*	*15%*
Street	$308	$322	$1,325	$1,484
BofA ML vs Street	Below	Below	Below	Above
EBITDA				
BofA ML est.	$79	$112	$462	$562
Street	$77	$113	$459	$544
BofA ML vs Street	Above	Below	Above	Above
EPS				
BofA ML est.	$0.14	$0.23	$0.95	$1.14
Street	$0.13	$0.21	$0.88	$1.07
BofA ML vs Street	In-Line	In-Line	Above	Above
Street EBITDA margins	25%	35%	35%	37%

Source: BofA Merrill Lynch Global Research estimates, Bloomberg, as of 4/4/2017

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Netflix (Buy, $154 PO)

Stock view: Easy comps ahead with more content on the way

Heading into 1Q earnings, we expect Netflix to beat subscriber estimates given strong recent content launches, and accelerating subscriber growth in Europe. Key 1Q titles included *A Series of Unfortunate Events*, *13 Reasons Why*, and Marvel's *Iron Fist*. We see few competitive issues this quarter to impact subscriber growth and we think the release of Marvel's Iron Fist likely helped quarter ending subscribers, despite low metacritic scores. Fans of the Defender series still seem to be watching the show with Parrot Analytics indicating viewership was just below Luke Cage its first week (though viewership dropped by half within the first 10 days). In addition, fan ratings came in at 81% on Rotten Tomatoes despite the poor critic reception.

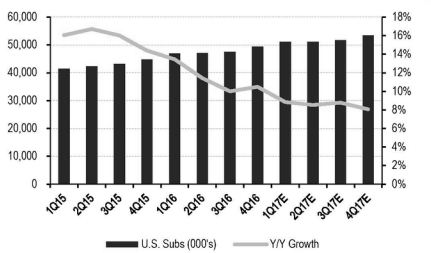
For 2Q, we expect a solid guide as Netflix laps 2Q16's price increases internationally and in the U.S. This should help churn rates for 2Q especially in Europe where we think the bulk of Netflix subscriber growth will originate for 2017. In addition, Netflix has a stronger slate of titles vs. 1Q including key franchises like *House of Cards*, *Orange is the New Black*, *Sense8*, and other new series. Although competition is increasing in the SVOD space with Amazon, Hulu and other making original content, we still see Netflix as ahead of the competition due to: 1) sheer volume of content production with over 1000 hours in 2016, with strong local market content that can be leveraged globally, 2) competitive price points vs competitors; and 3) the largest volume of 4K content which attracts new TV purchases. 4K TVs could drive upside to estimates in FY17 as Netflix is one of the few services with a library of 4K content.

For 1Q contribution margins, we estimate that Netflix will reach a new high at 41.3% U.S. contribution margins somewhat offset by international contribution margins which we expect to close to zero at 1.5%, but still a large improvement over 4Q's 8% loss. We expect Netflix to run its International division at new break even margins through FY17 and begin to gradually lift international margins in 2018. As Netflix reaches Intl profitability, the investor story may focus more on EPS growth in the coming years.

Key theme/metric(s) for 1Q: Net sub adds internationally and 2Q guide

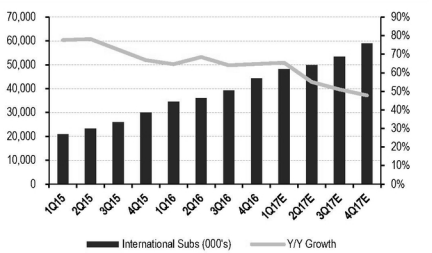
For 1Q we see two critical metrics that we think the Street will focus on; 1) Net Intl. subscriber additions as Netflix laps the launch in 130 countries globally; and 2) 2Q net subscriber guide for Netflix in the U.S. Although 1Q domestic subscriber ads are important, we think the Street would be willing to look past a lower domestic number on stronger international growth. In 2Q Netflix could potentially hit a flat subscriber growth quarter as 2Q is typically seasonally weak, though we note the content slate for 2Q16 has several top franchises with new seasons.

Chart 11: Domestic subscribers



Source: BofA Merrill Lynch Global Research estimates, company report

Chart 12: International subscribers



Source: BofA Merrill Lynch Global Research estimates, company repor

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Biggest issues/risks:

- Low reviews scores on Iron Fist effecting fan churn and causing some to question Netflix's ability to continue creating hit series
- Marketing spend in 1Q to drive subscriber growth
- Lower than expected contribution margins as Netflix invests in content.
- Content spending impact on FCF

Top 1Q data points: Traffic gains on PC

In the U.S., comScore reported quarter to date (Jan. and Feb.) average unique desktop visitors up down 2% y/y to 40.5 million compared to 4Q up 22% y/y or 47 million, while mobile unique users were flat y/y at 29.4mn users vs. up 19% y/y in 4Q. We note recent comScore changes heavily impacted the y/y comparable data for several companies including Netflix, in addition Comscore Data is PC only which is likely less relevant given that a large portion of Netflix viewing is through connected TVs/devices.

Estimates vs. Consensus: In-line on revenue, slightly below on EPS

Our 1Q rev/GAAP EPS estimates of $2.71bn/$0.39 are above the Street's estimates of $2.64bn/$0.37. We estimate total domestic subs of 51.1 million, domestic DVD subs of 4 million, and international streaming subs of 48.3 million. Netflix a solid line up of popular content in 2Q, especially May where it has *Sense8* Season 2, *Unbreakable Kimmy Schmidt* Season 3, *War Machine* (Movie), *House of Cards* Season 5 in May, and a remake of Anne of Green Gables and *Orange is the New Black* in June which will likely help U.S. domestic subscriber total stay positive in 2Q. In addition, we expect lower y/y churn rates to potentially help subscriber growth.

Table 18: Netflix estimate summary

	1Q17	2Q17	2017	2018
Revenue				
BofAML est.	$2,710	$2,854	$11,627	$13,937
Growth Y/Y%	*38%*	*35%*	*32%*	*20%*
Street	$2,644	$2,760	$11,221	$13,448
BofAML vs. Street	Above	Above	Above	Above
EBITDA				
BofAML est.	$331	$306	$1,218	$1,758
Street	$308	$245	$1,053	$1,710
BofAML vs. Street	Above	Above	Above	Above
GAAP EPS				
BofAML est.	$0.39	$0.30	$1.19	$2.04
Street	$0.37	$0.23	$1.09	$1.98
BofAML vs. Street	Above	Above	Above	Above

Source: BofA Merrill Lynch Global Research estimates, company report

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Pandora (BUY, $9 PO)

Stock view: Focus on on-demand product, but questions on growth
Pandora's recently launched on-demand subscription product will likely be the focus of 1Q investor call. Although the product is on limited release, we expect investor to focus on initial reception of the product (positive reviews in media) and whether Pandora is capable of growing the subscription base to 10mn over the next several years. Initially Pandora will not likely see an impact on revenue from premium subscriptions as it is giving current Pandora One subscribers a free six month trail of Pandora Premium which may also impact subscription revenue for 1Q.

From our initial time with Pandora Premium, we found playlist creation smooth and easy to use with Pandora quickly auto-filling play lists after picking a few songs, but Pandora lacks the curated playlist selection found in Apple music and Spotify and we encountered some missing songs/artists from the on-demand platform. The real question will be whether Pandora's platform is 1) good enough to pull exiting on-demand users from other services to Pandora (Pandora indicated roughly 60% of Pandora users are using another on-demand service); 2) can it convince people to upgrade from free Pandora to Pandora Premium; and 3) how will Pandora grow its active listener base from here. Pandora has had a largely stagnate active user base over the last year and we think even with the new on-demand product could face difficulty growing its users, especially as it increases its ad loads in key markets.

Key theme/metric(s) for 1Q: Ad rate growth and sub metrics
Pandora began rolling out Pandora Premium on March 15th, and we think key questions for the call will be; 1) initial reception of Pandora Premium; 2) when it will be fully available to all users; 3) will Pandora Premium driving increased users; and 4) how have ad load changes be received by free users. Pandora is increasing its ad load per hour to increase its RPM rates, but this also risks alienating its already stagnant to declining user base from the platform. 1Q will be the first measure to see if Pandora is able to increase ad loads while maintaining its user base, the first step in stronger monetization of its differentiated ad-supported radio product.

Biggest 1Q issues/risks:
- Investment spending in quarter and outlook for future S&M/R&D spend;
- Outlook for when Pandora will reach profitability again.
- Active listener or listening hour declines due competition;
- Commentary on outlook for Pandora Premium

Top 1Q data points: Triton Internet radio data
Triton media releases Internet radio metrics which give an initial read into the quarter, but is limited to January data, Triton data shows Avg. Active sessions (analogous to listening hour growth) declined 3% y/y which is tracking below our 1% y/y listener hour growth est. of 5.58 billion hours. Session starts were up 4% y/y above our est. of 1% y/y active user growth. We note that Spotify is now tracking more session starts than Pandora implying market share loss to Spotify. Given the leap year, we would expect February to track down Y/Y for monthly active listeners and user growth in February.

Estimates vs. Consensus: Slightly above on revenue, below on EPS
Our rev/Non-GAAP EPS est. of $319mn/($0.49) is slightly above on revenue, but in-line on EPS compared to the Street est. at $318mn/($0.39). We model total listener hours at 5.58bn and total RPM rates of $52. Our FY16 est. are slightly above on revenue, but well above on EPS as we expect losses this year to improve in 2H16 as Pandora builds up subs, but still see Pandora failing to gain much leverage from increased R&D spending and S&M spend. We maintain our $9 PO, based on 1x our 2018 revenue estimate, a discount to peers, but justified in our view as Pandora is likely to have a difficult transition year as it builds it on-Demand service.

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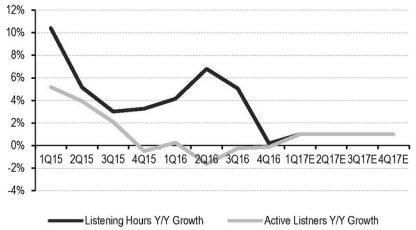
Table 19: Pandora estimate summary

	1Q17	2Q17	2017	2018
Revenue				
BofAML est.	$319	$397	$1,629	$2,036
Growth Y/Y%			*18%*	*25%*
Street	$318	$390	$1,621	$2,050
BofAML vs. Street	Above	Above	Above	Below
EBITDA				
BofAML est.	-$73	$1	-$17	$25
Street	-$73	-$16	-$38	$79
BofAML vs. Street	In-line	Above	Above	Below
EPS				
BofAML est.	-$0.49	-$0.04	-$0.21	-$0.19
Street	-$0.35	-$0.14	-$0.49	-$0.03
BofAML vs. Street	Below	Above	Above	Below

Source: BofA Merrill Lynch Global Research estimates, Bloomberg

Chart 13: Listening hours and active users trends are essentially flat.



Source: BofA Merrill Lynch Global Research estimates, company report

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Priceline (Buy, $1,920 PO)

Stock view: Expect solid 1Q top-line, but 2Q can be rough for guidance
Priceline's metric trends and commentary, along with 1Q booking and room night guidance, indicate that the company continues to capture strong market share growth in the category, with little impact from hotel direct booking initiatives or competitive OTA marketing spend. We expect a strong 1Q, with perhaps a little less upside than usual due to the late 4Q reporting date.

Looking forward to 2Q, we have our usual caution on guidance as 2Q is the most back-end loaded quarter for bookings and revenues. However, in 2017 the Easter shift is a positive factor and will help 2Q revenues and earnings. We also expect 1Q bookings and room night growth upside to translate into higher 2Q gross profit growth, and management indicated that there is less marketing ROI pressure expected in 1H'17 than in 2H'16. Overall, we expect Priceline's strong business trends to continue, and would use extra conservatism in guidance as a buying opportunity.

Given strong execution and higher exposure to more fragmented International markets, Priceline remains our top long-term idea in Online travel. However, on a near-term basis, we think Expedia could see a bigger stock benefit from an acceleration in room night growth over the summer.

Key theme/metric(s) for 1Q: Room night growth
We expect Priceline to report 26% y/y room night growth (deceleration v. 31% in 4Q), ahead of the company's outlook of 20-25% hotel room night growth. Priceline has a history of guiding 1Q conservatively, looking at Priceline's historical 1Q results for Bookings, revenue and EPS vs guidance suggests modest upside to our bookings growth forecast of 22% and reported 1Q'17 EPS closer to $9.55 (13% upside vs. the midpoint) vs. our estimate of $9.08 and the Street's estimate $8.75.

Table 20: 1Q Bookings Growth, Revenue Growth and EPS Guidance vs. Actuals

	1Q13			1Q14			1Q15			1Q16			1Q17		
	Guidance	Actual	Upside	Guidance	Actual	Upside	Guidance	Actual	Upside	Guidance	Actual	Upside	Guidance	Actual	Upside
Bookings	30-37%	36%	No	23-33%	34%	Yes	2-9%	12%	Yes	12-19%	21%	Yes	17-22%	??	
International Bookings FX-Neutral	35-42%	43%	Yes	25-35%	38%	Yes	17-24%	29%	Yes	N/A	N/A		N/A		
Revenue	17-24%	26%	Yes	15-25%	26%	Yes	4-11%	12%	Yes	9-16%	17%	Yes	N/A		
EPS	$4.90-$5.30	$5.76	Yes	$6.35-$6.85	$7.81	Yes	$7.20-7.75	$8.12	Yes	$9.00-9.60	$10.54	Yes	$8.25-8.65	??	

Source: BofA Merrill Lynch Global Research estimates, Bloomberg, Priceline

Biggest 1Q issues/risks:

- Concerns on threat of increasing marketing competition with Expedia and TripAdvisor
- Potential pressure on US inbound traffic given the Trump travel ban (unlikely to impact Priceline given high Intl exposure)
- Marketing deleverage – our model assumes 340bps of y/y online marketing deleverage in 1Q
- Pressure on hotel revenue take rates given less hotel participation in commission programs and longer booking windows

Early 1Q RevPAR data mixed
Priceline's Booking.com has roughly 1.2mn properties on its site (>611k hotels and 576k vacation rental properties). According to STR, 1Q US RevPAR through initial March readings decelerated 30bps to 3.0% y/y, and European RevPAR through February accelerated 600bps q/q to 3.6% y/y (FX-neutral). The STR data reflects a continued

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gradual deceleration in US RevPAR growth and a positive recovery in European RevPAR growth as the region laps terrorist attacks and geopolitical uncertainty.

Table 21: US and European RevPAR Y/Y Change

US	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17**	1Q16	2Q16	3Q16	4Q16	1Q17
Occupancy	-0.3%	-0.8%	-0.4%	2.2%	-0.5%	0.3%	-1.0%	-0.4%	1.6%	-0.3%	2.5%	-0.1%	0.5%	-0.5%	1.6%	-0.5%	0.7%	0.1%	0.7%	0.5%
ADR	2.8%	3.6%	3.2%	2.8%	2.4%	3.5%	3.6%	2.5%	3.9%	1.9%	3.4%	2.4%	3.2%	1.7%	2.6%	3.2%	2.9%	3.3%	2.6%	2.5%
RevPAR	2.4%	2.8%	2.7%	5.0%	1.9%	3.8%	2.5%	2.1%	5.6%	1.6%	5.9%	2.3%	3.8%	1.2%	4.2%	2.7%	3.6%	3.4%	3.3%	3.0%
Europe																				
Occupancy	1.4%	1.5%	0.3%	3.5%	-0.3%	-0.7%	-0.4%	-1.5%	0.8%	-0.4%	4.2%	4.5%	5.1%	2.9%		1.1%	0.8%	-0.4%	2.8%	4.0%
ADR	-4.3%	-2.7%	2.5%	3.2%	0.3%	-4.5%	-0.7%	-4.8%	-1.8%	-8.6%	-5.3%	-5.0%	-2.1%	-3.1%		-1.5%	-0.3%	-2.4%	-6.3%	-2.6%
RevPAR	-2.9%	-1.3%	2.8%	6.8%	-0.1%	-5.1%	-1.1%	-6.2%	-1.0%	-9.0%	-1.3%	-0.7%	2.9%	-3.1%		-0.5%	0.5%	-2.8%	-3.7%	-0.1%
Europe in Euros	**Jan-16**	**Feb-16**	**Mar-16**	**Apr-16**	**May-16**	**Jun-16**	**Jul-16**	**Aug-16**	**Sep-16**	**Oct-16**	**Nov-16**	**Dec-16**	**Jan-17**	**Feb-17**		**1Q16**	**2Q16**	**3Q16**	**4Q16**	**1Q17**
Occupancy	1.4%	1.5%	0.3%	3.5%	-0.3%	-0.7%	-0.4%	-1.5%	0.8%	-0.4%	4.2%	4.5%	5.1%	2.9%		1.1%	0.8%	-0.4%	2.8%	4.0%
ADR	0.0%	-0.2%	-1.7%	-0.1%	-0.9%	-4.4%	-2.7%	-4.6%	-1.6%	-8.5%	-5.4%	-1.5%	-0.9%	0.2%		-0.7%	-1.8%	-3.0%	-5.2%	-0.4%
RevPAR	1.4%	1.2%	-1.4%	3.3%	-1.2%	-5.0%	-3.1%	-6.0%	-0.9%	-8.9%	-1.4%	2.9%	4.2%	3.0%		0.4%	-1.0%	-3.3%	-2.4%	3.6%

Source: Smith Travel Research (STR), BofA Merrill Lynch Global Research estimates; Note: **March data is month to date

Estimates vs. Consensus: We are above the Street on EBITDA/EPS in 1Q

Our 1Q revenue/EPS of $2.4bn/$9.08 is broadly in line to slightly above the Street at $2.4bn/$8.75. We see upside to the company's 1Q EPS guide of $8.25-$8.65. We estimate 26% y/y hotel room night growth, some deceleration from 31% growth v. 4Q (guidance is 20-25%).

Table 22: Priceline Estimate Summary

	1Q17	2Q17	2017	2018	2019
Revenue					
BofAML est.	$2,415	$3,041	$12,518	$14,469	$16,493
Growth Y/Y%	*12%*	*19%*	*17%*	*16%*	*14%*
Street	$2,441	$2,998	$12,447	$14,323	$16,279
BofAML vs. Street	Below	Above	Above	Above	Above
EBITDA					
BofAML est.	$609	$988	$4,784	$5,476	$6,207
Street	$599	$966	$4,747	$5,515	$6,310
BofAML vs. Street	Above	Above	Above	Below	Below
EPS					
BofAML est.	$9.08	$15.45	$75.35	$87.19	$100.07
Street	$8.75	$14.84	$74.11	$86.36	$98.76
BofAML vs. Street	Above	Above	Above	Above	Above

Source: BofA Merrill Lynch Global Research estimates, Bloomberg, as of 4/4/2017

Our price objective is $1,920 based on 22x our 2018 adj. EPS estimate. The 22x multiple is towards the upper end of Priceline's historical multiple range of 13-23x and represents a PEG of 1.4x. We think a 22x forward P/E multiple is appropriate given mid-teens EPS growth, strong booking trends, Priceline's leadership position in the global online travel sector, track record of EPS upside, and increased access to the China via the Ctrip investment.

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Snap (Neutral, $25 PO)

Stock view: Long-term potential, but near-term could be lumpy
Snap will report its first earnings as a public company and expectations have a wide range. The 2H16 DAU slowdown has raised concerns in terms of both competitive risk and execution, so user trends could be the most important metric in the quarter. At this point, it's difficult to gauge relative impact of Facebook / Instagram competition, Android technical issues, product cycle lumpiness, and seasonality to the recent slowdown. Nonetheless, our sense is that DAU expectations are around 164-166mn, and we'd expect variability (higher or lower) to have a meaningful impact on stock sentiment.

In terms of the P&L, we expect a slight q/q decline in revenue per normal seasonality and are modeling down 1% q/q (consistent with comments in the prospectus filing). While we can appreciate the momentum of the API roll-out with several new partnerships announced in January, our checks suggest most programs are early stage with limited volume to date. Considering the rest of the P&L, we expect a fairly messy quarter between deal costs, the CEO stock award, and a catch-up RSU stock comp expense. As we do not anticipate non-GAAP profitability until 2H19, we expect traditional P&L metrics will be less of a focus in the coming quarters.

We recently initiated coverage with a Neutral and $25 price target (please see User overhang unlikely to be resolved in a Snap – Initiate at Neutral with $25 PO). Social media sector history suggests a wide range of possible outcomes for Snap and, as such, near-term lumpiness in metrics could result in high volatility for the stock. We also note that lock-up overhang could drag on near-term performance into the first lock-up expiration on 7/29.

Key theme/metric(s) for 1Q: DAUs, ARPU, and competition
We believe the key metric for the quarter will be the DAU number, which we model at 166mn (up 8mn q/q, 36% y/y). We believe DAU headwinds may peak 1H17 as the company is facing an onslaught of competitive products (see More Stories in the Snap competitive saga), technical challenges with Android (from Memories), and seasonality entering the summer. We model ARPU at $1.01 (down 5% q/q), with North America ARPU at $2.03 (down 7% q/q). We won't be surprised to see upside in ARPU driven by ad load growth and higher user engagement, though competitive pricing could potentially offset.

Biggest 1Q issues/risks:

- **DAU deceleration on share loss:** Anything short of 164mn will likely be met with skepticism as investors extrapolate recent trends in considering competitive resilience vs Instagram, Facebook, and others. Management will likely address the Android technical issues impact on DAUs.

- **Aggressive pricing could drive short term growth but have mixed perception:** Twitter noted elevated competition and potentially aggressive pricing surfacing in mid-January, which aligns well with Snap's API update.

- **Lack of visibility into pipeline:** While we don't necessarily expect new product announcements, lack of color/visibility on the product pipeline could disappoint.

- **Results could leave investors looking for more disclosure:** We are not sure what disclosure Snap will provide on results, and important trending info (like average minutes per user) could be lacking.

Top 1Q data points: comScore suggests some gains for Instagram
While comScore data is not consistent with reported minutes, it is useful for relative comparisons. The data puts Snapchat minutes per user well above Twitter, but still

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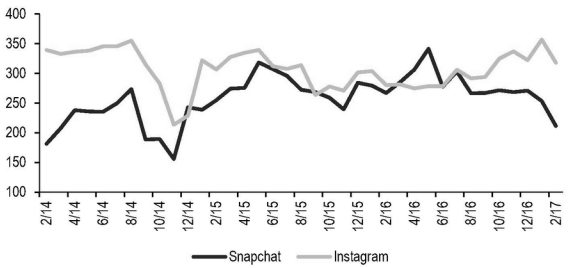
trailing Instagram and Facebook. Interestingly, after Snapchat passed Instagram in early 2016 in average minutes per user, Instagram recaptured the lead mid-year and has extended it since. While the cause for the shift is not certain, the trends align with the launch of Instagram Stories (August 2016) as well as some technology challenges on the Snapchat front (Android). Regardless of the near-term lumpiness, we believe overall daily engagement puts Snapchat in a strong position to capture emerging online marketing ad budgets.

Table 23: Average minutes per user trend

	Aug-2016	Sep-2016	Oct-2016	Nov-2016	Dec-2016	Jan-2017	Feb-2017
Snapchat	267	267	272	269	271	254	211
Instagram	292	294	325	337	322	357	318
Facebook	769	766	855	826	781	827	700
Twitter	143	149	139	114	108	128	110

Source: comScore, BofA Merrill Lynch Global Research

Chart 14: Instagram vs Snapchat average monthly minutes per visitor



Source: comScore

Estimates vs Consensus

Our 1Q revenue estimate of $163mn (down 1% q/q) is slightly above consensus at $158mn (down 5%), but we note the range of estimates is considerable ($130-196mn) and some checks suggest that Snap was aggressive with advertisers in 1Q. For the year, our $1.0bn revenue estimate is mostly in-line with the Street, as is our 2018 estimate at $2.1bn. We do not model positive adjusted EBITDA until 2Q19, and expect investors to focus mostly on user revenue trends.

Table 24: Snap Estimate Summary

	1Q17	2Q17	2017	2018	2019
Revenue					
BofA ML est.	$163	$208	$1,007	$2,057	$3,719
Growth Y/Y%	*320%*	*190%*	*149%*	*104%*	*81%*
Street	$158	$206	$1,034	$2,032	$3,303
BofA ML vs Street	Above	Above	Below	Above	Above
EBITDA					
BofA ML est.	-$168	-$158	-$580	-$335	$276
Street	-$180	-$194	-$617	-$392	$80
BofA ML vs Street	Above	Above	Above	Above	Above
EPS					
BofA ML est.	-$0.18	-$0.15	-$0.59	-$0.37	$0.12
Street	-$0.21	-$0.13	-$0.57	-$0.33	$0.00
BofA ML vs Street	Above	Below	Below	Below	Above

Source: BofA Merrill Lynch Global Research estimates, Bloomberg, as of 4/4/2017

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Our $25 PO is based on our DCF model as we do not expect the company to be profitable until mid- to late-2019 and any earnings-based valuation exercise would require discounting back future earnings. Our DCF assumes approximately $28bn revenue by 2027 based on 525mn DAUs and $50+ in ARPU. Our PO implies 15.5x EV / Revenue, above the peer group at 4x, as we believe Snap's early stage of ad monetization and potential future leverage in the business model warrants a premium valuation multiple to the social media group.

HOUSE_OVERSIGHT_014922

TripAdvisor (Underperform, $40 PO)

Stock view: EBITDA under pressure, brand ad spend not in Street estimates yet
2016 was a re-platforming year, and with Instant Book fully rolled out globally, the company aims to re-educate visitors on its booking offering. However, we think most TripAdvisor visitors (399mn average monthly unique visitors in 2017 and 148mn average monthly hotel shoppers) still view the site as a review/research portal, and changing customer behavior will be quite difficult, particularly as we do not think TripAdvisor has clarified its value proposition for shoppers.

While we think that TripAdvisor's elevated marketing spend in 2017 will drive a rebound in traffic, we anticipate a poor ROI. Marketing expense continues to ramp as Instant Book rolls out, though traffic growth slows, implying more costly traffic acquisition. In 4Q'16, Sales & Marketing as a % of sales increased to 52.8% vs. 45.6% in 4Q'15, and we think TripAdvisor essentially bought desktop Hotel Shopper traffic, though likely at poor ROI. However, higher marketing spend in 2017 does not yet include potential for a likely return to expensive brand ad campaigns. In our brand ad spend scenario analysis, we expect still more downside to estimates (see Taking a look at TripAdvisor's potential brand ad spend).

The company is encouraged by Revenue per Hotel Shopper growth continuing to improve from down 21% y/y in 1Q. We expect growth continues its improvement trend in 2017. However, if monetization trends decelerate, earnings downside could be significant. We think it will be difficult for TripAdvisor's Hotel revenue to return to growth next year, let alone double-digit y/y growth, given the mobile monetization headwinds. However, if the company invests heavily in traffic acquisition, particularly on higher monetizing desktop, revenue and traffic growth may reaccelerate meaningfully in 2017, though with ongoing pressure on margins.

Chart 15: Quarterly revenue and Sales & Marketing per Hotel Shopper y/y growth

Source: BofA Merrill Lynch Global Research estimates, company report

Key theme/metric(s) for 1Q: Update on ad spend targets, 2017 guidance
TRIP's outlook for 2017 is based on "prioritizing revenue growth as opposed to profit growth," which implies far lower marketing return expectations. However, TRIP notes this expectation for marketing spend does not include potential for a return to brand marketing, which could be an incremental $50-70mn headwind in '17, in our view.

Biggest 1Q issues/risks:

- Marketing spend: TripAdvisor has prioritized revenue growth at the expense of earnings, implying poor marketing ROI. The biggest issue facing TripAdvisor is if it decides to pursue an expensive brand/TV marketing campaign which would further drive further earnings downside.

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- Instant Book impact: The Instant Book transition could impact meta rates and total monetization as more hotel shoppers flow through large OTA partners.

- Hotel Shopper growth: Given elevated marketing spend, we expect to see a rebound in hotel shopper and hotel revenue growth. 4Q16 hotel shopper growth accelerated from 3% in 2Q-3Q16 to 8%. We expect hotel shopper growth to decelerate slightly to 6% in 1Q17 on a 200bps tougher y/y comp.

1Q traffic data points: comScore indicates solid mobile and PC user growth

In the US, comScore reported quarter to date through February, average monthly unique visitors of 31mn on PC and 56mn on mobile, up 24% and up 3% y/y, respectively. TripAdvisor total minutes in 1Q through February is up 10%, with mobile minutes up 5% and PC minutes up 17%. In our view, TripAdvisor's elevated marketing spend YTD likely targets higher monetizing PC traffic.

Estimates vs. Consensus: Broadly in-line on Revenue, below on EBITDA/EPS

Our 1Q revenue estimate of $379mn is broadly in line with the Street at $377mn. We are more cautious on EBITDA and EPS at $71mn/$0.23 vs. the Street at $76mn/$0.27.

Table 25: TripAdvisor estimate summary

	1Q17	2Q17	2017	2018	2019
Revenue					
BofAML est.	$379	$432	$1,647	$1,794	$1,936
Growth Y/Y%	*8%*	*10%*	*11%*	*9%*	*8%*
Street	$377	$433	$1,649	$1,852	$2,095
BofAML vs. Street	Above	Below	Below	Below	Below
EBITDA					
BofAML est.	$71	$88	$346	$403	$471
Street	$76	$88	$339	$392	$530
BofAML vs. Street	Below	Above	Above	Above	Below
EPS					
BofAML est.	$0.23	$0.31	$1.22	$1.57	$1.89
Street	$0.27	$0.32	$1.23	$1.48	$2.28
BofAML vs. Street	Below	Below	Below	Above	Below

Source: BofA Merrill Lynch Global Research, Bloomberg, as of 4/4/2017

Our price objective of $40 is based on 25x our 2018 non-GAAP EPS estimate. This multiple represents a modest premium to the group for possibly depressed margins and potential for re-accelerating top-line growth.

HOUSE_OVERSIGHT_014924

Trivago (Buy, $15 PO)

Stock view: Advertising continues to drive growth engine

Trivago's 4Q revenue and EBITDA results highlight the company's rapid revenue growth and potential for solid profitability. Though there are concerns over the company's large marketing spend (80-85% of revenue), we think the Street will view Trivago's results positively given continued revenue ramp while also achieving profitability. The stock remains highly volatile given the limited float. Commentary during 4Q'16 earnings from Trivago's key customers Expedia and Priceline (as well as from TripAdvisor) indicated that paid traffic has been growing faster than free traffic, and that companies in the sector planned to ramp ad spend to drive continued traffic growth, which is a positive for Trivago.

Trivago has best-in-class revenue growth, with 2017 revenue growth expected at 47% (vs. guidance of 45%+), led by 50% qualified referral growth. We also expect Trivago will become more efficient with advertising and start to reap the benefits of past brand advertising, with return on advertising spend (ROAS) improving across regions in 2017, a key driver of modestly improving EBITDA margin from 3.7% in 2016 to 3.9% in 2017.

The company remains in growth mode, led by click revenue growth in ROW and Americas regions, as Trivago is driving brand awareness outside its key European foothold through aggressive brand marketing. The company is adding qualified referrals at an accelerating rate as it expands beyond its core Developed Europe markets and penetrates new markets. We think the company has significant runway for growth and can sustain 30%+ revenue growth through the end of the decade. As the business matures in its new Americas and ROW markets, we expect a better balance between profit and growth. We think EBITDA margins should accelerate as the company leverages '16 and '17 marketing spend, with greater uplift in '18.

Key theme/metric(s) for 1Q: Qualified referral growth

We forecast 56% qualified referral growth in 1Q (920bps deceleration on 730bps tougher y/y comp), led by 38% y/y growth in Developed Europe, 48% in Americas, and 110% in ROW. We expect continued robust marketing spend will drive user growth.

Biggest 1Q issues/risks:

- Weak return on advertising spend (ROAS) may be an earnings headwind. Competition in the company's advertising channels may result in lower ROI trends. The company may also see less efficient advertising in newer, less mature markets.
- A positive update to 2017 guidance may be expected. Trivago currently expects total revenue growth of 45%+ and adjusted EBITDA margin is guided to flat to slightly up vs. 2016's 3.7%.

Estimates vs. Consensus: Expect revenue in-line vs. the Street, EBITDA ahead

For 1Q, we expect revenue/EBITDA of €241mn/(€12mn) vs. the Street at €241mn/(€10mn). We expect 2017 and 2018 revenue and EBITDA to come above the Street and expect there is room for upside to management's 2017 revenue growth and EBITDA margin guidance.

Table 26: Trivago Estimate Summary

	1Q17	2Q17	2017	2018	2019
Revenue					
BofAML est.	€241	€281	€1,105	€1,498	€1,984
Growth Y/Y%	*52%*	*57%*	*47%*	*36%*	*32%*
Street	€241	€270	€1,088	€1,497	€2,035
BofAML est. vs. Street	Below	Above	Above	Above	Below
EBITDA					
BofAML est.	€12	€6	€44	€127	€262
Street	€10	€6	€40	€98	€197
BofAML est. vs. Street	Above	Below	Above	Above	Above
EPS					

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Table 26: Trivago Estimate Summary

	1Q17	2Q17	2017	2018	2019
BofAML est.	€0.02	€0.00	€0.05	€0.22	€0.48
Street	€0.02	€0.01	€0.06	€0.15	€0.32
BofAML est. vs. Street	Above	Below	Below	Above	Above

Source: BofA Merrill Lynch Global Research estimates, Bloomberg, as of 4/4/2017

Our PO of $15 is based on a 3.5x 2018E EV/Sales multiple. We note that 3.5x is roughly in line with the lead generation peer group average 2018E EV/Sales multiple. We think our EV/Sales multiple is warranted as a balance between Trivago's higher growth and lower profitability. Our price objective is supported by our DCF analysis.

HOUSE_OVERSIGHT_014926

Wayfair (Neutral, $44 PO)

Stock view: Timeline on profitability still an issue, but comps ease in 2Q'17

Wayfair's two issues have been deceleration in U.S. revenue growth and negative operating margins as the company continues to aggressively invest in logistics, international expansion, marketing, and new categories. 1Q customer and order growth comps remain tough, which was one of the drivers of revenue growth guidance below expectations. Wayfair also attributed weak guidance to caution on the retail environment and added investment. Growth comps ease in 2Q/3Q, and there is potential for more stable growth in 2Q guidance to drive improving investor sentiment.

As for margins, management guided to EBITDA margin of (3.5%)-(3.8%), a deceleration from (2.8%) in 1Q'16 due to a lower opex absorption in the quarter on seasonally lower sales. The US is expected to swing back to EBITDA losses in 1Q'17, while Intl losses are expected to remain steady. We forecast EBITDA margin of (2.4%), with (0.2%) EBITDA margin in the US and (19.0%) margin in International. The company continues to expect little to no ad spend leverage given increase International ad spend.

Management historically builds conservativism into its guidance and, until last year, had a track record of beating the upper end of its sales outlook by ~10%. Recently, revenue has been by a low-single digit percentage. Our above consensus 1Q revenue forecast implies 1% upside to the high end of the guidance range, in line with the trend over the past 3 quarters. We think investors expect sales growth above the guidance range as well.

Table 27: Revenue and EBITDA Guidance vs. Actuals

	4Q14	1Q15	2Q15	3Q15	4Q15	1Q16	2Q16	3Q16	4Q16	1Q17E**
Revenue - High End of Guidance	$370,000	$390,000	$440,000	$525,000	$665,000	$700,000	$785,000	$850,000	$960,000	$930,000
Revenue Actual	$408,619	$424,371	$491,752	$593,972	739,790	747,348	786,928	861,525	984,559	943,626**
Revenue Upside	$38,619	$34,371	$51,752	$68,972	$74,790	$47,348	$1,928	$11,525	$24,559	$13,626
Revenue % Upside	10%	9%	12%	13%	11%	7%	0%	1%	3%	1%
EBITDA - High End of Guidance %	-4.5%	-3.5%	-2.5%	-0.8%	-0.8%	-3.0%	-3.2%	-4.3%	-2.8%	-3.5%
EBITDA - High End of Guidance	($16,650)	($13,650)	($11,000)	($3,938)	($4,988)	($21,000)	($25,120)	($36,125)	($26,400)	($32,550)
EBITDA Actual	($7,218)	($12,340)	($4,972)	($1,445)	$2,828	($20,960)	($24,857)	($30,849)	($12,026)	($22,463)**
EBITDA Upside	$9,432	$1,310	$6,028	$2,493	$7,816	$40	$263	$5,276	$14,374	$10,087

Source: BofA Merrill Lynch Global Research, Wayfair

Note: * 1Q17E Actuals are current BofA Merrill Lynch forecasts

Over the past two quarters, Wayfair has expressed caution on the macro environment, though this proved to be somewhat unwarranted in 4Q. According to February 2017 aggregated BAC credit and debit card data, furniture sales were up 1.3% (down 0.4% on rolling 3-month m/m basis), while home goods were down 1.2% y/y and flat on a rolling 3 month m/m basis. Please see the BofA Merrill Lynch US Economics team's report for additional commentary on broader retail trends and a detailed explanation of the methodology and limitations in connection with BAC data. Williams-Sonoma reported disappointing 4Q earnings (March 15th report) and provided modest 1Q guidance that the BofA Merrill Lynch Hardline Retail team called "a little rich," though it is difficult to tell if weak trends are the result of secular home goods weakness or the disruptive impact of eCommerce players like Wayfair.

Key theme/metric(s) for 1Q: 2Q revenue guidance on easier y/y comps

1Q revenue guidance was a disappointment, though comps ease in 2Q'17, and opportunity for more stable US growth could aid stock sentiment. Customer growth in 2Q has a 400bps easier y/y comp vs 1Q17, while order growth has a 1700bps easier y/y comp. Overall, revenue growth faces a 1600bps easier y/y comp. and would expect guidance anywhere near the Street's 2Q estimate at 25% y/y growth to be viewed positively given several quarters of guidance below street estimates.

HOUSE_OVERSIGHT_014927

Biggest 1Q issues/risks:

- Commentary on US customer trends, particularly repeat rates and unit economics (customer acquisition costs).
- AOV trends given street concerns that some customer metrics are benefitting from purchase of lower value items.
- Progress with International investments, especially early results from ad spending in UK, Canada, and Germany.

1Q data points indicate mixed traffic trends

US data indicates that Wayfair PC minutes growth increased 17% y/y in 1Q through February vs. 14% y/y growth in 4Q'16. Wayfair mobile minutes have decreased 24% y/y through February in 1Q vs. up 3% y/y in 4Q'16. US PC user growth decreased 16% y/y in 1Q through February, vs. 4Q at -25% y/y. Wayfair mobile user growth increased 2% y/y in 1Q through February vs. 16% y/y in 4Q.

Estimates vs. Consensus: Expect revenue and EPS upside vs. the Street

For 1Q, we expect revenue/EBITDA of $944mn/($22mn) vs. the Street at $933mn/($32mn). Total revenue guidance of $905-930mn implies 2-year stacked growth of 97-101% vs. 121% in 2016, which seems conservative. We expect the company's revenue to come in above the high end of the sales outlook as Direct Revenue sales were up 30% quarter to date (through nearly 2 months of 1Q'17). Our 1Q revenue growth forecast is based on 48% y/y customer growth (up 9% q/q) and 42% order growth (down 10% q/q). Wayfair expects EBITDA margin of (3.5%)-(3.8%) due to a lower opex absorption in the quarter on seasonally lower sales. The company continues to expect little to no ad spend leverage given increase International ad spend.

Table 28: Wayfair Estimate Summary

	1Q17	2Q17	2017	2018	2019
Revenue					
BofAML est.	$944	$980	$4,169	$5,019	$5,872
Growth Y/Y%	*26%*	*25%*	*23%*	*20%*	*17%*
Street	$933	$987	$4,237	$5,258	$6,585
BofAML vs. Street	Above	Below	Below	Below	Below
EBITDA					
BofAML est.	-$22	-$19	-$48	$10	$64
Street	-$32	-$20	-$59	$23	$134
BofAML vs. Street	Above	Above	Above	Below	Below
EPS					
BofAML est.	($0.49)	($0.46)	($1.55)	($1.00)	($0.47)
Street	($0.60)	($0.45)	($1.65)	($0.94)	$0.04
BofAML vs. Street	Above	Below	Above	Below	Below

Source: BofA Merrill Lynch Global Research estimates, Bloomberg, as of 4/4/2017

Our PO of $44 is based on 0.7x 2018E EV/sales. We continue to focus on EV/Sales given Wayfair's lack of profitability due to US fulfilment investment and Intl. expansion. Our 0.7x target multiple is a discount to Wayfair's eCommerce comp group at 1.3x and at a modest discount to a retail peer comp group at 0.8x. We think the multiple is appropriate given strong revenue growth vs. peers, balanced by lower profitability.

HOUSE_OVERSIGHT_014928

Twitter (Underperform, $14.50)

Stock view: Engagement could be improving, but still trailing peers
On positive note, DAU growth, tweet impressions, and time spent growth have all been accelerating, and we won't be surprised if most metrics show stable growth in 1Q17 given event activity (political, sports, awards shows) in 1Q. However, the NFL season is over, the election surprise is slowing fading, competitive pressure is rising (particularly Instagram), and new monetization initiatives will take time, so we are more cautious on 2Q. The high level of executive churn also raises an element of strategic uncertainty that could continue to weigh on sentiment. While it's possible Twitter could see moderate residual benefit from recent YouTube/Google Display Network boycotts, we continue to believe MAU growth acceleration is key to improving sentiment, and we continue to expect other platforms to grow much faster. The biggest upside driver for 1Q could be conservative guidance, which implied revenues would be down 17% y/y at the midpoint in 1Q.

Longer-term, our primary concerns are user growth, rising competition in video, and lack of positive advertiser feedback. Despite execution on the live streaming initiative in 2016, MAU impact was underwhelming and we see risk of rising costs and/or content loss in 2017. At this point, it's unclear how aggressively management will push live streaming in 2017, and early exploration of potential subscription revenue streams (enhanced Tweetdeck offering beta) could suggest potential strategic shifts. On the advertiser side, we are still hearing limited traction with Twitter's ad platform changes and ROI measurement, and it seems experimental dollars are being moved to Snap.

The biggest risk to our Underperform rating, in our view, is the underlying value of the Twitter platform for users and potential Artificial Intelligence (AI) signals. We remain on the sideline for now, with ever-present M&A potential providing some element of a floor to the stock. We think 3x 2017 revenues plus cash ($12/share in total) is a valuation an acquirer could see as very reasonable given stabilizing DAU trends and value of Twitter data.

Key theme/metric(s) for 1Q: Mgmt focus on engagement, investors on users
MAU growth likely remains the primary focus in terms of metrics investors consider. While DAU growth could continue to growth at high single digits, we do not see much upside potential to low single digit MAU growth (we model 322mn, 4% y/y), which lags in comparison to Facebook's recent17% y/y growth. We expect engagement metrics in general (tweet impressions, DAU growth, time spent) to be solid, though it's possible lack of NFL and fading US election catalysts could have some negative effect. In terms of monetization, our ARPU estimate for $1.67 implies a 14% y/y decline, which reflects both weaker Twitter pricing trends and potential competitive pricing pressures.

Biggest 1Q issues/risks:

- **MAU growth could slip:** We model 4% y/y MAU growth to 322mn, but fading NFL and election tailwinds could lead to weaker user growth trends in 2Q.
- **Competition could impact pricing:** Management noted elevated competition in mid-January (shortly after Snap's ad API update), which may have continued throughout the quarter and impacted pricing more than anticipated.
- **Live streaming pipeline in question:** Amazon recently announced a deal with the NFL to steam game content, replacing Twitter.
- **Ad product wind-down could impact revenue:** Management indicated that it is reevaluating lower return ad formats, and a decision to wind down certain formats (like direct response, promoted tweets) could further impact 2Q guidance.

HOUSE_OVERSIGHT_014929

Top 1Q data points

comScore mobile data indicated US monthly active users were up 2% y/y and down 4% q/q (down 3mn q/q), versus our estimate for +4% y/y, +1% q/q. Total minutes for 1Q17 (2-mo. data) are tracking down 18% y/y, with mobile down 18% and desktop down 23%. Mobile minutes have averaged a 20% y/y decline for the last 4 months.

Estimates vs Consensus

Our 1Q17 rev/EPS estimates for $535mn/$0.03 are slightly above the Street and above the implied midpoint of management's guidance (based on EBITDA and EBITDA margin outlook). Despite our near-term concerns, we believe the outlook was sufficiently conservative. That said, we see risk to current consensus estimates for the year, and we are below Street revenue at $2.3bn for 2017 vs consensus at $2.35bn, though slightly ahead on EBITDA on more moderate cost assumptions. Our 2017 estimates assume a conservative 4% MAU growth for the year.

Table 29: Twitter Estimate Summary

	1Q17	2Q17	2017	2018
Revenue				
BofA ML est.	$535	$544	$2,301	$2,339
Growth Y/Y%	*-10%*	*-10%*	*-9%*	*2%*
Street	$510	$548	$2,352	$2,496
BofA ML vs Street	Above	Below	Below	Below
EBITDA				
BofA ML est.	$120	$152	$639	$689
Street	$94	$135	$564	$650
BofA ML vs Street	Above	Above	Above	Above
EPS				
BofA ML est.	$0.03	$0.08	$0.33	$0.34
Street	$0.01	$0.06	$0.27	$0.37
BofA ML vs Street	Above	Above	Above	Below

Source: BofA Merrill Lynch Global Research, Bloomberg, as of 4/4/2017

Our $14.50 price objective is based on 12x our 2018 EBITDA estimate, which reflects a discount to the online media group (13x). We believe the Twitter platform has slowing user and revenue growth and as such, we expect the stock to trade at a sustained discount to online media peers, with potential M&A adding some offsetting downside support.

HOUSE_OVERSIGHT_014930

Yelp (Neutral, $43 PO)

Stock view: Likely to be some improvement vs last quarter

Yelp is coming off of a quarter with decelerating app unique devices, weak new customer adds, and decelerating sales force growth, and it seems likely that one or two of these metrics will improve. The tone at our recent investor meetings with the CFO seem to suggest that 4Q issues did not signal a break in the model (see On the road with Yelp), and we expect an improvement q/q customer adds. We think the company should be able achieve Street 1Q revenue and EBITDA estimates, though we won't be surprised to see the 2Q17 outlook come in slightly below current Street estimates.

For the full year outlook, while we believe the implied expense growth in the 2017 outlook is somewhat conservative, management appears focused on investing in the business for now and we think upside is more likely to come in 2Q or 3Q. Overall, we remain somewhat cautious on the stock given potential revenue deceleration due to tough comps and a deceleration in sales force growth.

On the cost front, management has been clear in its intention to invest in performance marketing, which could take time to bear fruit. In addition, we believe sales force growth to stabilize/increase going forward, which would seem to suggest potential cost headwinds relative to recent quarters. Finally, while we don't have the specific financials, the addition of Nowait ($40mn acquisition closed 2/28) likely encompasses a moderate bump up in opex with limited revenue to offset.

As we look ahead, we are encouraged with the three transitions within company and we will be looking for progress on the following on the call. The first is connections between consumers and businesses on Yelp through clicks, reservation services, ordering, and Request a Quote. The second is a ramp up in performance marketing as users engage in more measurable events. The third is new customer acquisition via alternative channels, including national customers from outside sales alongside self-serve customers via online channels.

Key theme/metric(s) for 1Q: new account adds, app unique devices growth

Given the miss last quarter and pressure on sales force headcount, local advertising accounts will be important gauge of overall execution. Other key metrics include app unique devices growth, which has been decelerating since mid-2015 from 51% y/y to 20% in 4Q16. Performance marketing could reverse the trend, but it could take some time. Finally, while management continues to highlight a decoupling of sales force growth and topline trends, investors still pay attention to overall sales force growth, particularly given the three consecutive quarters of deceleration from 44% y/y (1Q16) to 11% y/y (4Q17). Management has indicated that sales force growth in 2017 should be in the double digits.

Table 30: Key 1Q metrics

Metrics	4Q16A	1Q17E	2Q17E
Claimed Local Business	3,363	3,552	3,727
y/y Growth	27%	25%	24%
Local Advertising Accounts	138	142	150
y/y Growth	24%	17%	17%
Reviews	121,022	127,135	133,635
y/y Growth	27%	25%	23%

Source: BofA Merrill Lynch Global Research, company reports

Biggest 1Q issues/risks:

- **Local revenue deceleration:** We assume 750bps of y/y growth deceleration in 1Q17 vs 4Q16.

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- **Metrics could remain under pressure:** Investors likely will look for stabilization in key metrics such as app unique devices growth and local ad account growth, but it could take time for incremental marketing and sales investments to bear fruit.

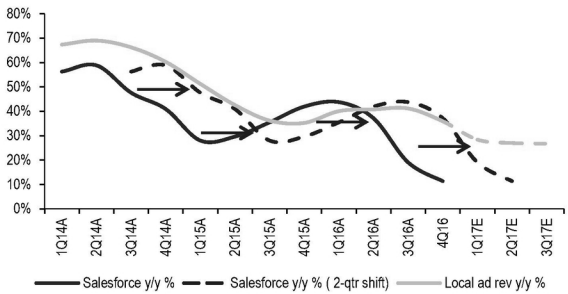
- **Stock comp could create overhang:** With Alphabet's decision to only report GAAP profits, Yelp's high stock comp (67% of 2017E EBITDA) could create overhang to the valuation.

Leading indicator data points:

Salesforce growth decelerating

While it possible that Yelp sees improving productivity per salesperson, and the mix shift to national and self-serve reduces reliance on direct sales, the deceleration in salesforce headcount is a negative leading indicator for revenues.

Chart 16: Salesforce growth versus local advertising revenue growth

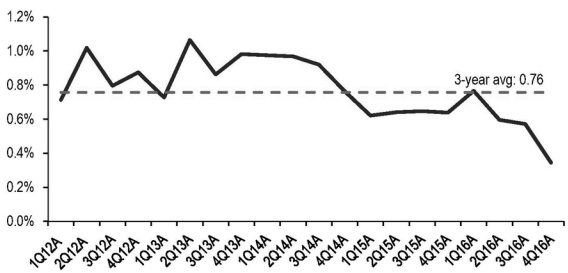


Source: Company, BofA Merrill Lynch Global Research

Accrued sales bonus and commissions tracking lower

We note that 4Q accrued bonuses and commissions are down y/y and reflect only 0.3% of NTM revenue, which would be the lowest ratio seen in recent years. Even on an absolute basis, the total accrued bonuses and commissions of $3.1mn is the lowest since mid-2013. While this is likely due in part to gains in self-serve and perhaps increased sales focus on National accounts, the change is noteworthy, in our view.

Chart 17: Accrued bonuses and commissions as a % of NTM revenue



Source: Company, BofA Merrill Lynch Global Research

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In addition, the y/y change in commissions expense disclosed in company filings continued a downward trend to negative territory. Over the course of 2016, the number has gone from +$5.7mn in 1Q16, to +$2.4mn in 2Q16, to +$1.4mn in 3Q16, to down $1.7mn in 4Q16.

We also consider comScore mobile data, which indicated that US monthly active users were up 2% y/y (2-months data) while desktop monthly active users were down 14% y/y. This reflects a moderate deceleration in mobile from 4Q (+4%) and slightly lower declines in desktop (4Q at -16%). Total QTD US minutes are down 6% y/y for mobile (vs +4% in 4Q), though App minutes were flat, and desktop was up 6% y/y (vs +1% in 4Q). The somewhat weaker mobile minutes trend is notable, particularly the lack of growth in

Estimates vs Consensus

Our revenue and EBITDA estimates are slightly above consensus for both 1Q17 and 2Q17, as well as for 2017 and 2018. We expect local ad revenue to grow 28% y/y in 1Q (vs 36% in 4Q) and transaction revenue to grow 17.5% (vs 19% in 4Q). Our 2017 estimates are near the high end of management's 2017 outlook, and we would expect any upside potential to likely surface in the latter half of the year.

Table 31: Yelp Estimate Summary

	1Q17	2Q17	2017	2018
Revenue				
BofAML est.	$201	$218	$895	$1,082
Growth Y/Y%	*26%*	*26%*	*26%*	*21%*
Street	$198	$215	$889	$1,068
BofAML vs. Street	Above	Above	Above	Above
EBITDA				
BofAML est.	$31	$40	$166	$221
Street	$27	$37	$161	$217
BofAML vs. Street	Above	Above	Above	Above
EPS				
BofAML est.	$0.18	$0.24	$0.99	$1.28
Street	$0.16	$0.25	$1.04	$1.45
BofAML vs. Street	Above	Below	Below	Below

Source: BofA Merrill Lynch Global Research, Bloomberg, as of 4/4/2017

We are more constructive on the stock given more negative sentiment and recent sell-off, but maintain our Neutral rating given the decelerating sales leading indicator metrics and tougher revenue comps. Our $43 price objective is based on 14x 2018E EV/EBITDA, slightly above online media comps, which we believe is warranted given the higher margin potential in the model. We believe our multiple balances premium growth vs peers with medium-term concerns on competition and limited GAAP profitability. We believe the slight premium valuation is sustainable if the company can continue to deliver 20%+ y/y topline growth, which would be above the advertising industry.

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Zillow (Buy, $42 PO)

Stock view: controversy sounding the mortgage business

While we still expect Zillow's core business to have a solid quarter on product improvements, the self-serve platform, and its recent Seller Boost product, the controversy surrounding Zillow's mortgage business (which potentially has implications for Zillow's core business and the retail estate industry) has been a key recent driver of the stock. The Consumer Financial Protection Bureau (CFPB) has indicated that it views Zillow's mortgage referral system as potentially violating parts of the Real Estate Settlement Procedures Act (RESPA). RESPA (Real Estate Settlement Procedures Act) is an act designed to product potential homeowners by outlawing kickback and referral fees from real estate services, particularly in relation to mortgage brokers who often receive referrals from real estate agents. Since Zillow's mortgage referrals involve a pre-application and a referral directly to a mortgage agent that than a larger entity like a bank, this could be violating the act. Mortgage brokers often fund some of the real estate agents online advertising expenses and a crackdown on mortgage agents could potentially hurt real estate agents ability to spend dollars on Zillow.

For now it is too early to say how this will develop as there are conflicting views for and against this view with the CFPB not releasing an official stance, but we expect this to be a near term overhang on the stock until a clear view of the CFPB's view and intentions unfold. While a contentious issue, mortgage revenue is still only 8% of total revenue and even a cut back would have a minimal impact to overall revenue growth. As for the impact on real estate agent spend on Zillow, we believe at with only roughly 5% penetration into real estate agents online spend Zillow has plenty of room to grow the core business and the high ROI of the ad unit will ensure agents buy placements on Zillow regardless of mortgage broker involvement and continue to like the stock.

Key theme/metric(s) for 1Q: Mortgage requests and revenue per loan

With the controversy surrounding the mortgage business, we think investors will be extra focused on the mortgage unit and focus on the mortgage revenue per loan request and consumer load requests. Zillow will be releasing new metrics this quarter to replace ARPA and premier agent count, but has yet to indicate what those metrics will be. Key topics for the call will likely include: 1) mortgage business outlook; 2) premier agent advertising spend; 3) rentals business; and 4) progress on FY17 goals.

Biggest 1Q issues/risks:

- If the CFPB decides Zillow violates RESPA, Zillow could face fines and have to retool its mortgage platform.
- New metrics for FY17 could give less visibility into the business as a whole.
- Slower than expected penetration of self-service platform leading to increased S&M costs.
- Potential for a weak 2Q guide if mortgage issues overhang the business as a whole.

Top 1Q traffic data points: comScore suggests usage up in 1Q

comScore desktop data suggests that unique visitors were down 5% quarter to date (Jan. and Feb.) while usage was up 2% QTD. However, on mobile, comScore data suggests usage is up 14% y/y on a bigger unique visitor base to 62mn unique users and usage was up 7%. We note comScore has made several methodology changes which has impacted the consistency of recent months data.

Estimates vs. Consensus: We are above the Street

Over rev/EBITDA estimates of $239mn/$40mn is above the Street at $236mn/$39mn. We estimate that ARPA will be up 29% y/y to $629 and premier agent subscribers will be flat y/y at 91.9K. Overall, we estimate 28% y/y growth, but note that the mortgage issues could potentially impact revenue. For rentals and other we estimate $32mn in revenue, up 75% y/y.

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Table 32: Zillow estimate summary

	1Q17	2Q17	2017	2018
Revenue				
BofAML est.	$239	$261	$1,062	$1,307
Growth Y/Y%			*25%*	*23%*
Street	$236	$257	$1,048	$1,258
BofAML vs. Street	Above	Above	Above	Above
EBITDA				
BofAML est.	$40	$51	$215	$313
Street	$39	$46	$211	$298
BofAML vs. Street	Above	Above	Above	Above
EPS				
BofAML est.	$0.06	$0.11	$0.48	$0.89
Street	$0.05	$0.07	$0.44	$0.80
BofAML vs. Street	Above	Above	Above	Above

Source: BofA Merrill Lynch Global Research estimates

Zillow has effectively captured the online U.S. real estate market, allowing them to accelerate monetization and access to a large TAM with $87bn in total real estate commissions paid in 2016 and Zillow powering just 5% of the commissions through its Premier Agent platform. Although there is potential for the mortgage business to create a headwind if the CFPB issued a negative ruling against Zillow, we still like the stock into the quarter, as we prefer business with minimal competition, and believe that the high ROI of the real estate premium platform to real estate agents will ensure agents buy placements on Zillow regardless of mortgage broker involvement. We maintain our $42 PO based on a 6x our 2018E EV/Sales and supported by our DCF valuation. Our multiple is roughly in-line for online real estate lead generation sites in other countries operating in developed countries.

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Zynga (Underperform, $2.70)

Stock view: Live events can improve franchises, but still need new titles
Zynga launched Dawn of Titans end of 4Q, and although it progressed into the top 20 grossing games in the U.S. Apple store, it has fallen out of the top 100 at some points during the quarter suggesting that its overall revenue contribution has been fairly low. While this is somewhat disappointing, we think investor expectations for the game are now at reasonable (lower) levels.

Instead of big new title launches, Zynga has indicated it is focused on strengthening its current franchises with better engagement and monetization through live events and new features, and progress in this area is key for the 2017 stock outlook. Zynga Poker (up roughly 80% y/y YTD) appears to be benefiting from the focus on engagement and live events with much stronger monetization, which could offset declines in other titles. Overall, we think it could be hard to get the Street excited on the stock without a strong future title that could drive more than single digit growth.

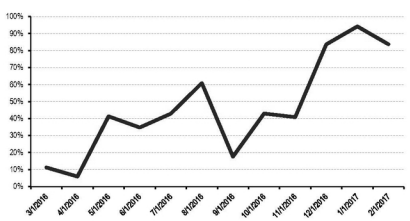
Key theme/metric(s): DAUs, and live events impact on DAU trends
After launching 10 new games in 2016, Zynga is focusing more heavily on live events to drive engagement with in franchises rather than launching additional titles. This should, if successful, translate into better DAU metrics as consumer engage with a title more often. With Dawn of Titan likely coming below Street expectations, stronger engagement will be necessarily for Zynga to drive a stronger DAU base. For the quarter, we model 17.9mn online game DAUs for 1Q, down slightly q/q, and down 6% y/y.

Biggest issues/risks:

- **Dawn of Titans revenues:** Zynga spend several years developing the game and lack of title success could impact sentiment.
- **Expense leverage and cost-cutting benefits do not materialize**: Zynga plans to further improve operational efficiency and potentially cut non-profitable franchises, but this may be hard to do without impacting long term growth opportunities.
- **Lack of new releases**: Zynga gave no indication of when it will release its next title leaving current franchises to carry revenue and earnings.

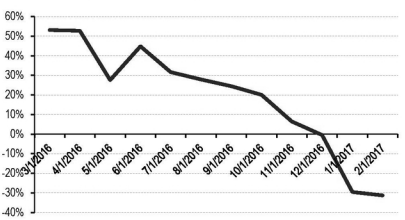
Top data points: Zynga game bookings tracking in-line to slightly below est.
Zynga's largest revenue generating franchises, Zynga Poker was up significantly in 1Q. Zynga Poker appears to be benefiting from live events and is tracking up roughly 89% QTD. Combined slots titles appear a bit more challenged with total revenue down 30% QTD y/y, in part due to lower monetization on Wizard of Oz slots which is tracking down in gross gaming rankings. Overall, QTD (January and February) Zynga online game bookings (ex-ad revenue) is tracking up 7% y/y vs our 1Q est. of bookings up 9% y/y.

Chart 18: Zynga Poker y/y revenue growth



Source: Superdata Research, BofA Merrill Lynch Global Research

Chart 19: Zynga slots y/y revenue growth



Source: BofA Merrill Lynch Global Research estimates, company report

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Estimates vs. Consensus: Mostly inline to the Street

We are slightly above the street on revenue at $189mn vs. $188mn, but in-line on EBITDA at $20mn. Cost cutting could improve EBITDA and Zynga has restructured some of its workforce and is focusing on driving more engagement with live events in its game franchises. For 2017, we are below the Street on revenue at $779mn vs. $805mn, but above on EBITDA at $101mn vs $99mn.

Table 33: Zynga Estimate Summary

	1Q17	2Q17	2017	2018
Revenue				
BofA ML est.	$189	$196	$779	$786
Growth Y/Y%	*41%*	*41%*	*5%*	*1%*
Street	$188	$200	$805	$875
BofA ML vs Street	Above	Below	Below	Below
EBITDA				
BofA ML est.	$20	$20	$101	$106
Street	$20	$24	$99	$122
BofA ML vs Street	Above	Below	Above	Below
EPS				
BofA ML est.	$0.01	$0.01	$0.05	$0.06
Street	$0.02	$0.02	$0.07	$0.08
BofA ML vs Street	Below	Below	Below	Below

Source: BofA Merrill Lynch Global Research estimates, company report

Zynga is improving profitability while engaging players better with live services but we remain cautious on the company's ability to materially grow its audience and still favor the console gaming group. Zynga should have downside support given roughly $1.50 in cash and assets and strategic franchise value (we estimate Poker/Slots generates over $250mn+ in revenue annually). Our $2.70 PO is based on 11x 2018E EBITDA (which is a premium to the Mobile gaming peer group due to margin expansion potential), plus $1.41/share in cash and assets (building).

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Company referenced	Ticker	Price
Alphabet A	GOOGL	848.91
Alphabet C	GOOG	831.41
Amazon.com	AMZN	909.28
Bankrate	RATE	9.75
Care.com	CRCM	11.68
eBay	EBAY	33.81
Expedia	EXPE	124.97
Facebook	FB	141.85
Fitbit	FIT	5.71
GrubHub	GRUB	33.27
LendingTree	TREE	117.8
Match Group	MTCH	16.45
Netflix	nflx	143.62
ONDK	ONDK	4.62
Pandora	P	11.82
priceline.com	PCLN	1761.77
Quotient	QUOT	9.4
Snap	SNAP	20.7
TripAdvisor	TRIP	41.76
Trivago	TRVG	12.81
Twitter	TWTR	14.53
Wayfair	W	40.21
Yahoo!	YHOO	46.38
Yelp	YELP	33.22
Zillow A	ZG	33.49
Zillow C	Z	33.47
ZYNGA	ZNGA	2.78

Source: BofA Merrill Lynch Global Research, Prices as of 5 April 2017

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Price objective basis & risk

Alphabet (GOOGL / GOOG)
Our price objective is $1025/$1025, representing 17x our core 2018 Google non-GAAP EPS estimate (excluding non-Google losses), plus $118/share in cash, or 21x core Google GAAP EPS plus cash. Alphabet has traded at 12-24x forward P/E over the last five years and we think our 17x multiple is reasonable given shareholder friendly actions that include the non-core revenue and operating loss disclosures, and stock buybacks.

Downside risks to our PO are: 1) Search revenue growth decelerates faster than anticipated due to market maturity, 2) mobile transition drives negative search behavior changes, 3) revenue growth pressure from competitor initiatives, 4) margins disappoint due to revenue mix and investment initiatives, and 5) negative regulatory changes, including EU antitrust. The stock has been subject to heavy volatility in the past based on revenue growth and margin trends and this volatility could increase if economic conditions deteriorate.

Amazon.com (AMZN)
Our PO of $1,100 is based on our SOP that values AWS at $127bn or $259 per share and the retail business at $413bn or $841 per share. Our 5.5x AWS multiple is a modest premium to the software/SaaS comp group at 5.0x on 2018 sales, and 0.9x multiple is a premium to a retail general merchandise comp group at 0.7x. We think the premiums are warranted given share gains and superior growth. Our $1,100 price objective implies 2.8x 2018E Price/Sales, a multiple above the high end of Amazon's historical range of 1.0-2.5x. We argue the historical P/S multiple should increase given positive 3rd party sales (3P) that is reported on a net basis, a higher AWS revenue contribution, and record gross profit margins.

Downside risks to our price objective are a consumer spending slowdown, rich P/E multiple, margin or growth pressure from the digitization of media, more aggressive offline competition, hardware strategy, AWS investments and/or price cuts, Prime Instant Video content costs, and decelerating growth. The stock has been subject to heavy volatility in the past, based on margin trends, and this volatility could increase due to economic uncertainty.

Bankrate (RATE)
Our $13 price objective is based on 9x our 2018E EV/EBITDA, a slight discount to the online lead-gen and marketplace peer group average of 11x. We believe it is reasonable for RATE to trade at a slight discount given RATE's recent challenges to both growth and margins and its position as a turnaround in the space.

Downside risks to our PO are: 1) limited visibility into intra-quarter trends, 2) stock dependent on economic outlook, 3) card issuer spending is volatile and the turnaround is short lived, 4) slower growth in personal loans than expected, 5) higher than expected marketing spending to drive traffic to Bankrate sites, resulting in lower margins, 6) Google changes have a negative impact on marketing margins and EPS, 7) competition with other consumer finance sites, and 8) a large acquisition.

Care.com (CRCM)
Our $9 price objective is based on 1.3x 2018E EV/Sales or 10x 2018E EV/EBITDA, in line with small cap ecommerce and subscription peers. Care.com has category leadership and a large TAM, but we do not believe 7% 2-yr expected revenue growth warrants a premium to peers. At the same time, we believe that the Google Capital investment could provide some downside support on take-out potential.

Downside risks to our PO are 1) need to add more customers each year to grow given high churn, 2) competition from SitterCity and Homestead, and 3) new care offerings

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(mobile apps, premium nanny, date night payment services etc.) may not see much traction, 4) lower conversion rates on mobile, 5) mobile conversions with 30% fee to Apple and Google Play marketplaces could negatively impact margins, and 6) international expansion may not be successful given different demographics.

Upside risks to our PO are 1) lower marketing spend resulting in higher margins and better leverage in 2016, 2) revenue upside from cross-selling and word of mouth, 3) increase length of stay for paid subscribers, reducing churn, and 4) traction from new care offerings, Care at Work, and international expansion.

eBay (EBAY)
Our $38 price objective is based on 17x our 2018E EPS. Our 17x P/E multiple is slightly ahead of the retail comp group average of about 16x, reflecting eBay's potential for a Marketplace growth acceleration in 2017.

Risks to our price objective are: 1) competition from Amazon and other new Marketplaces in the U.S., competition from Amazon, Alibaba and local incumbents in International markets, and competition from multi-channel retailers that are aggressively investing in the online channel, 2) vulnerability to future Google algorithm changes, 3) decelerating user growth, resulting in eCommerce market share losses, and 4) currency risk including FX volatility impact on cross border trade. The stock has been subject to heavy volatility in the past based on GMV growth and market share trends and this volatility could increase due to economic uncertainty.

Expedia (EXPE)
Our $146 price objective is based on our sum of the parts (SOP) that assumes 9x 2018E EBITDA for the core OTA business (a discount to Priceline at approx. 15x due to slower organic growth and higher taxes on earnings), 8x 2018E EBITDA for Egencia (we expect single digit growth), 60% ownership of Trivago (using our PO), and HomeAway at 15x 2018 EV/EBITDA.

Downside risks to our PO are: 1) economic downturn leading to fewer travel bookings, 2) competition for European traffic lowering the company's growth or margin opportunity, 3) hotels favoring lower-cost alternative distribution channels and limiting Expedia's access to inventory, 4) Google and/or TripAdvisor disintermediation, and 5) the negative impact of terrorism and disease on global travel trends.

Facebook (FB)
Our $165 price objective is based on 24x our non-GAAP 2018E EPS and 27x GAAP EPS, multiples equal to about 1x 2018E revenue growth, mostly in-line with its social and online media peers.

Risks are: 1) high valuation that discounts strong growth, 2) changes in user engagement impacts optimism on revenue opportunities and compresses the stock multiple, 3) privacy issues or pushback on Facebook's policy changes impact revenue generation, 4) risks to executing Messenger & WhatsApp monetization, 5) potential for higher investment to negatively impact margins, and 6) a macroeconomic impact on advertising pricing.

Fitbit (FIT)
Our $6.50 price objective is based on 0.5x EV/S multiple which is below the device manufacturer peer group at 1.8x, but justified in our view given declining revenue and profitability, FCF burn, market saturation, and limited visibility into the next product cycle.

Upside risks are: 1) international product launches and expansion, 2) higher-than-expected ASPs, 3) new product launches domestically, 4) slower-than-expected OpEx ramp, 5) software monetization and 6) corporate wellness program growth.

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Downside risks are: 1) integration risk from smartwatches and other wearables cannibalizing the fitness tracker market, 2) fad risk, as fitness trackers could be simply a fitness fad with consumers, 3) competitive risk from competitors out-innovating, and 4) execution risk on channel build and inventory management.

GoPro (GPRO)
Our $8 price objective is based on 10x our 2018E EBITDA, in line with the peer average of 10x, which we believe is appropriate given its slightly higher growth and potential for EBITDA margin expansion after restructuring. GoPro is the leading action camera company in the world but has been challenged by execution issues limiting its ability to drive strong product cycles.

Downside risks to our PO are: 1) new products fail to resonate with consumers, 2) competitive pressure pushing down ASPs, and 3) failure to meet market demand during holidays.

Upside risks to our PO are: 1) better than expected sales on new products, 2) better than expected holiday sales from extra manufacturing capacity, 3) better than expected drone sales, or new product announcements, and 4) new direct sales partnerships internationally

GrubHub (GRUB)
Our PO is $49, based on 32x our 2018E P/E (vs. high growth internet at 31x). We believe GRUB warrants a premium to eCommerce peers due to the attractive margins of the core business and, relative to the overall small-cap sector, GRUB has more attractive margins and growth potential.

Downside risks to our PO are:
Revenue and sales metrics are trailing KPIs for Diners and Restaurant and the potential for diminishing returns on future restaurant and user additions is a risk. GrubHub has significant room for growth in the US ahead, but will need to invest internationally if domestic growth stalls.

LendingTree (TREE)
Our $140 price objective represents 14x 2018E EV/EBITDA, a premium to the lead generation services and marketplace peer group average of 11x due to market position (category leader in mortgage and personal loans) and faster revenue growth.

Risks to achieving our estimates and price objective are: 1) interest rate risks given the demand for leads for mortgage and other loan products, 2) competition with other consumer finance sites and ad networks, 3) potential for search engine disintermediation and traffic competition, 4) potential for recessionary impact on loan products (lower traffic and demand for leads) and credit card markets, 5) premium valuation vs. lead generation and marketplace peers, and 6) acquisition risk.

Match Group (MTCH)
Our PO is $21 based on 12x our estimated 2018 EBITDA of $562mn and our DCF valuation analysis. The basis for our PO is in-line with the eCommerce group, but a premium to the consumer internet subscription services group due to MTCH's combination of market dominance, profitability, and cash flow. We think fundamentals help MTCH stand out from its ecommerce peer group and MTCH should be seen as a more defensible platform that is unlikely to see disruption in its core markets.

Downside risks are: market share losses to an emerging dating business, potential for higher acquisition costs on mobile, lower conversion rates that lead to lower PMC growth, the need to acquire competing sites to maintain growth or market share, and

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higher-than-expected International investments. The biggest downside risk is lower revenue if Tinder experiences a decline in popularity or public perception.

Netflix, Inc. (NFLX)
Our $154 price objective is based on a peak penetration sum-of-the-parts analysis which discounts back future EPS at peak penetration by 10%. At peak penetration, we assume domestic streams peak at 65mn subscribers in five years while the international segment reaches 200mn seven years later. We assume APRU of $9.99 and 40% contribution margins for the domestic business and a $8.50 APRU and 40% contribution margin for the international business. We also assume a $1.50 price increase domestically over six years and a $3.60 price increase internationally over twelve years which will be 75% incremental to operating income. We assume a US tax rate of 40% and an international tax rate of 25%. At peak penetration, we assume a 15x S&P average multiple.

Downside risks to our price objective are: 1) increasing content costs, 2) potential new competitors in the company's streaming business, 3) execution challenges and competition potentially limiting growth in new markets, 4) U.S. saturation point approaching quicker than expected, and 5) net neutrality repeal causing ISPs to look to recoup higher rents from Netflix's high bandwidth requirements for streaming.

Upside risks to our price objective are: 1) content costs rising slower than expected, 2) total subscriber growth is faster than expected, and 3) international expansion into new large markets (e.g. China).

OnDeck Capital (ONDK)
Our $6 price objective is based on 10x our 2018E EBITDA. This is below the internet ecommerce comparable group (11x) which is justified in our view given OnDeck's double digit revenue growth and potential to expand margins starting in 2018 as it gains scale and operating leverage, but tempered by a slower FY18.

Upside risks to our PO are: 1) faster than expected originations growth, 2) signing of new large strategic partners, and 3) lower than expected operating expenses.

Downside risks to our PO are: 1) higher than expected loss rates from worsening macro environment, 2) credit market freeze shutting down liquidity access, 3) lower effective yield from competition, and 4) increased marketing spend.

Pandora Media, Inc. (P)
Our $9 price objective is based on 1x our 2018 revenue estimate, a significant discount to online media and subscription service peers, but justified in our view as the multiple takes into account the company's difficult transition to a subscription on-demand service and lack of near term profitability balanced by the value of its data and user base.

Upside risks to our PO are: 1) direct licensing agreements for lower royalty rates, 2) international expansion announcements, 3) ad-load increases in key demos, increasing monetization rates, 4) faster than expected launch of on-demand service, and 5) the company is acquired.

Downside risks to our PO are: 1) emerging competition from both other Internet models like Spotify and Apple Music, as well as large, established radio companies like iHeartMedia embracing Internet streaming, 2) slow down in the company's ability to grow monetization, 3) lack of historical or near-term GAAP profitability, and 4) delayed on-demand service launch

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priceline.com (PCLN)
Our price objective is $1,920 based on 22x our 2018 adj. EPS estimate. The 22x multiple is towards the upper end of Priceline's historical multiple range of 13-23x and represents a PEG of 1.4x. We think a 22x forward P/E multiple is appropriate given mid-teens EPS growth, strong booking trends, Priceline's leadership position in the global online travel sector, track record of EPS upside, and increased access to the China market via the Ctrip investment.

Risks to our PO are 1) a global economic downturn, especially macro-weakness in Europe, leading to fewer travel bookings and pressure on room rates, 2) competition for traffic lowering the company's growth or margin opportunity, 3) hotels favoring their own distribution channels, 4) FX volatility, 5) increased competition from Expedia, TripAdvisor and potentially Google, and 6) the impact of terrorism/disease on global travel trends. The stock has been subject to heavy volatility in the past based on travel industry trends and this volatility could increase due to greater economic uncertainty, especially with macro-trends in Europe.

Quotient Technology Inc (QUOT)
Our $13 price objective is based on a 16x 2018E EBITDA, a premium to eCommerce peers (11x), which we think is justified given stickiness of the Retailer IQ platform and the slightly higher growth of 14% in FY17 vs. eCommerce group at 11%). Quotient is a lead operator in online couponing, has a strong technological platform, relationships with CPGs and a platform that is slowly spreading across grocers in the U.S.

Downside risks are: 1) further delays in point-of-sale system rollout with retailers, 2) loss of major retailers or CPG, 3) higher-than-expected R&D and S&M costs due to investment, and 4) limited float may contribute to volatility.

Upside risks to our analysis are: 1) additional retailers launching on their point-of-sale system, 2) quicker-than-expected transition to digital couponing, 3) new additional digital coupon retail clients (such as Walmart). and 4) targeted couponing lifting average transaction pricing.

Snap (SNAP)
Our $25 PO is based on our DCF model as we do not expect the company to be profitable until mid- to late-2019 and any earnings-based valuation exercise would require discounting back future earnings. Our DCF assumes approximately $28bn revenue by 2027 based on 525mn DAUs and $50+ in ARPU. Our PO implies 15.5x EV / Revenue, above the peer group at 4x, as we believe Snap's early stage of ad monetization and potential future leverage in the business model warrants a premium valuation multiple to the social media group.

Upside risks to our PO are: 1) greater than expected reacceleration in North America DAU growth, 2) more rapid monetization of existing user base with increased ad load and/or new ad formats, and 3) better traction and monetization in International markets.

Downside risks to our PO are: 1) further deceleration in user growth that would raise concerns on long-term revenue opportunity, 2) pressure on usage due to competing services, and 3) performance into the first lock-up expiration on 7/29/17.

TripAdvisor (TRIP)
Our price objective of $40 is based on 25x our 2018 non-GAAP EPS estimate. This multiple represents a modest premium to the group for possibly depressed margins and re-accelerating top-line growth.

Downside risks to our price objective are: 1) increasing competition (e.g. Yelp), 2) macro-economic factors (e.g. recession in Europe) impacting the travel industry, 3) challenges

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to the credibility of online reviews, 4) Instant Book transition puts pressure on revenue growth, and 5) mobile monetization headwinds.

Upside risks to our price objective are: 1) improved mobile monetization 2) major OTA sign on for instant booking 3) high non-hotel shopper dollar capture and 4) improved global macro environment.

Trivago NV (TRVG)
Our PO of $15 is based on a 3.5x 2018E EV/Sales multiple. We note that 3.5x is roughly in line with the lead generation peer group average 2018E EV/Sales multiple. We think our EV/Sales multiple is warranted as a balance between Trivago's higher growth and lower profitability. Our price objective is supported by our DCF analysis.

Downside risks to our price objective are: 1) Growing competition, 2) Elevated marketing spend, 3) High Customer concentration, 4) Macro and FX risks, and 5) Potential for loss of hotel inventory.

Twitter (TWTR)
Our $14.5 price objective is based on 12x our 2018 EBITDA estimate, which reflects a discount to the online media group (13x). We believe the Twitter platform has slowing user and revenue growth and as such, we expect the stock to trade at a sustained discount to online media peers, with potential M&A adding some offsetting downside support.

Downside risks to our PO are: 1) decelerating user growth that may raise concerns on long-term revenue opportunity, 2) pressure on usage due to emergence of competing services, 3) new ad initiatives may not perform well, resulting in lower advertiser demand for Twitter ads, 4) monetization of logged-out users and third party application users are slow to materialize, and 5) on a EV/EBITDA basis Twitter is more attractive today than in the past, but stock remains subject to multiple compression.

Upside risks to our PO are: 1) User adds could ramp on new product initiatives in the 2H, and accelerating user growth may increase optimism on long-term revenue opportunity, 2) with new demographic targeting initiatives, Twitter is able to capture more TV dollars (vs online ad dollars) that are incremental with video ads, 3) the NFL broadcasts and other video content (live political, entertainment, etc.) could help Twitter grow users meaningfully in the long term, 4) guidance could prove to be conservative, 5) traction from monetization of logged-out users and 6) potential that Twitter could be acquired.

Wayfair (W)
Our price objective of $44 is based on 0.7x 2018E EV/sales. We continue to focus on EV/Sales given Wayfair's lack of profitability to date. Our 0.7x target multiple is a discount to W's eCommerce comp group and at a modest discount to W's retail comp group. We think the multiple is appropriate given stronger revenue growth vs. peers, balanced by lower profitability and competitive risks.

Downside risks are: 1) GAAP operating losses expected through 2018, making valuation analysis more complex, 2) competition from several well capitalized companies including Amazon, 3) brand complexity (5 brands), 4) category limitations, 5) partner segment revenue headwinds, and 6) execution risk on International expansion.

Yahoo! (YHOO)
Our price objective of $57 is based on our sum-of-parts valuation assumptions. Our $53 estimated asset value represents $39/share from the remaining Alibaba stake (using $122 Alibaba valuation {10% discount rate, mid-term FCF FY18-25E CAGR of 18%, 4% terminal growth} x 384mn shares at 20% discount rate), $6.1 for Yahoo Japan, $0.5 for Excalibur patents, and $6.9 in cash and cash equivalents on Yahoo's balance sheet. We

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assume $4.7/share in value for the core business based Verizon's pending acquisition value of $4.83bn less $300mn for potential revisions.

Downside risks to our PO are: 1) Alibaba stock valuation declines, 2) Alibaba valuation discount is higher than expected, 3) Verizon's pending acquisition of Yahoo core assets is delayed/challenged, 4) valuation of Yahoo! Japan falls, and 5) valuation of Excalibur patent portfolio falls.

Yelp (YELP)
Our $43 price objective is based on 14x 2018E EV/EBITDA, slightly above online media comps, which we believe is warranted given the higher margin potential in the model. We believe our multiple balances premium growth vs peers with medium-term concerns on competition and limited GAAP profitability. We believe the slight premium valuation is sustainable if the company can continue to deliver 25% y/y topline growth with y/y margin improvement.

Downside risks are Google and Facebook's ambitions to build a review ecosystem to tap into local ad spending, competition from a variety of online and offline locally focused advertising businesses, Google traffic dependency, and advertiser churn.

Zillow (ZG / Z)
Our $42 price objective is based on a 6x our 2018E EV/Sales and supported by our DCF valuation. Our multiple is roughly in-line for online real estate lead generation sites in other countries operating in developed countries. In addition, this multiple represents a relative discount given Zillow's higher sales growth and a larger US TAM in comparison to its peers in smaller developed markets like Australia and Japan. We are positive on Zillow's long term opportunity to capture the majority of realtor's dollars moving from offline channels to online marketing channels.

Downside risks are: 1) traffic cannibalization between Zillow properties, 2) new lawsuits again Zillow, 3) potential for multiple compression, 4) a U.S. housing market down turn, and 5) lack of profitability support for valuation.

Upside risks are: 1) faster than expected growth and S&M leverage, 2) Zillow Digg monetization, 3) accelerated grow the in rentals market, and 4) new market expansion.

ZYNGA (ZNGA)
Our $2.70 PO is now based on 11x 2018E EBITDA (which is a premium to the Mobile gaming peer group due to margin expansion potential), plus $1.41/share in cash and assets (building).
Downside risks to our price objective are mobile market share losses, challenges in establishing successful new content given employee departures, and player churn due to greater competition given low barriers to entry. Upside risks are successful new title releases that accelerate growth, or potential acquisition of Zynga for its game portfolio.

Analyst Certification

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US - Internet Coverage Cluster

Investment rating	Company	BofA Merrill Lynch ticker	Bloomberg symbol	Analyst
BUY				
	Alphabet	GOOGL	GOOGL US	Justin Post
	Alphabet	GOOG	GOOG US	Justin Post
	Amazon.com	AMZN	AMZN US	Justin Post
	Bankrate	RATE	RATE US	Nat Schindler
	eBay	EBAY	EBAY US	Justin Post
	Expedia	EXPE	EXPE US	Justin Post
	Facebook	FB	FB US	Justin Post
	GrubHub	GRUB	GRUB US	Nat Schindler
	IAC InterActive	IAC	IAC US	Nat Schindler
	LendingTree	TREE	TREE US	Nat Schindler
	Match Group	MTCH	MTCH US	Nat Schindler
	Netflix, Inc.	NFLX	NFLX US	Nat Schindler
	OnDeck Capital	ONDK	ONDK US	Nat Schindler
	priceline.com	PCLN	PCLN US	Justin Post
	Take-Two Interactive	TTWO	TTWO US	Justin Post
	Trivago NV	TRVG	TRVG US	Nat Schindler
	Wix.com	WIX	WIX US	Nat Schindler
	Yahoo!	YHOO	YHOO US	Justin Post
	Zillow	ZG	ZG US	Nat Schindler
	Zillow	Z	Z US	Nat Schindler
NEUTRAL				
	Activision	ATVI	ATVI US	Justin Post
	Electronic Arts	EA	EA US	Justin Post
	Quotient Technology Inc	QUOT	QUOT US	Nat Schindler
	Snap	SNAP	SNAP US	Justin Post
	Wayfair	W	W US	Justin Post
	Yelp	YELP	YELP US	Justin Post
UNDERPERFORM				
	Care.com	CRCM	CRCM US	Justin Post
	Fitbit	FIT	FIT US	Jason Mitchell
	GoPro	GPRO	GPRO US	Jason Mitchell
	Pandora Media, Inc.	P	P US	Nat Schindler
	TripAdvisor	TRIP	TRIP US	Nat Schindler
	Twitter	TWTR	TWTR US	Justin Post
	ZYNGA	ZNGA	ZNGA US	Justin Post
RVW				
	Chegg	CHGG	CHGG US	Nat Schindler

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Disclosures

Important Disclosures

Equity Investment Rating Distribution: Electronics Group (as of 31 Mar 2017)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	29	59.18%	Buy	14	48.28%
Hold	5	10.20%	Hold	2	40.00%
Sell	15	30.61%	Sell	5	33.33%

Equity Investment Rating Distribution: Media & Entertainment Group (as of 31 Mar 2017)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	40	56.34%	Buy	21	52.50%
Hold	16	22.54%	Hold	6	37.50%
Sell	15	21.13%	Sell	6	40.00%

Equity Investment Rating Distribution: Technology Group (as of 31 Mar 2017)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	126	59.43%	Buy	70	55.56%
Hold	35	16.51%	Hold	17	48.57%
Sell	51	24.06%	Sell	17	33.33%

Equity Investment Rating Distribution: Global Group (as of 31 Mar 2017)

Coverage Universe	Count	Percent	Inv. Banking Relationships*	Count	Percent
Buy	1578	51.33%	Buy	979	62.04%
Hold	690	22.45%	Hold	434	62.90%
Sell	806	26.22%	Sell	381	47.27%

* Issuers that were investment banking clients of BofA Merrill Lynch or one of its affiliates within the past 12 months. For purposes of this Investment Rating Distribution, the coverage universe includes only stocks. A stock rated Neutral is included as a Hold, and a stock rated Underperform is included as a Sell.

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Investment rating	Total return expectation (within 12-month period of date of initial rating)	Ratings dispersion guidelines for coverage cluster*
Buy	≥ 10%	≤ 70%
Neutral	≥ 0%	≤ 30%
Underperform	N/A	≥ 20%

* Ratings dispersions may vary from time to time where BofA Merrill Lynch Research believes it better reflects the investment prospects of stocks in a Coverage Cluster.

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TED2017 program

Monday, April 24, 10:15AM - 12:00PM PDT

TED Fellows Talks, Session 1

Amazing talks and performances from the new class of TED Fellows and returning Senior Fellows. Hosted by Fellows director Tom Rielly.

Monday, April 24, 1:15PM - 3:00PM PDT

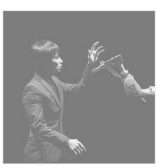
TED Fellows Talks, Session 2

Part 2 of the TED Fellows session, featuring cutting-edge work from TED Fellows and Senior Fellows. Unmissable.

Monday, April 24, 5:00PM - 7:00PM PDT

Session 1: One Move Ahead

Hosted by Chris Anderson
Not attending TED2017? Watch Session 1 – Opening Event – broadcast to cinemas! Find showtimes



Huang Yi

Choreographer, dancer, inventor

As a child, Huang Yi longed for a robot companion. As an adult, he created a robot to dance with: KUKA.

Taiwanese dancer, choreographer, inventor, and videographer Huang Yi's pioneering work is steeped in his fascination with the partnership between humans and robots. He interweaves continuous movement with mechanical and multimedia elements to create a form of dance which corresponds with the flow of data, effectively making the performer a dancing instrument. Named by *Dance Magazine* as one of the "25 to Watch," Huang is one of Asia's most prolific choreographers.

Harmoniously weaving together the art of dance and the science of mechanical engineering, HUANG YI & KUKA is a poetic work that intertwines modern dance and visual arts with the realm of robotics, revealing humanity through a series of vignettes between live dancers and KUKA, a robot conceptualized and programmed by Huang. "Dancing face to face with a robot is like looking at my own face in a mirror...I think I have found the key to spin human emotions into robots," Huang asserts.

HUANG YI & KUKA is an original production of Huang Yi Studio +, developed at 3LD Art & Technology Center, in association with Sozo Artists. Commissioned by Quanta Arts Foundation.

facebook.com/HuangYiStudio

Anab Jain

Futurist, designer

Superflux co-founder and TED Fellow Anab Jain parses uncertainties around our shared futures to create provocative experiences, tools and tactics that we can adopt today.

In 2009, Anab Jain co-founded the design firm Superflux with Jon Ardern, inspired by influences as far-flung as avant-garde architecture and Andrei Tarkovsky. The challenges Jain explores are some of the biggest -- climate change, biotech, intelligent machines -- and her resulting work "navigates the entangled wilderness of our technology, politics, culture and environment to imagine new ways of seeing, being and acting."

In her work, Jain creates worlds, stories and tools that provoke and inspire us to engage with the precarity of our rapidly changing world. Superflux is building tools, methods and commons that can enable us to mitigate the shock of food insecurity and climate change. Recently they produced a series of civilian drones, and created a vision of a near-future city where these intelligent machines begin to display increasing autonomy with civic society. Among Superflux's previous projects is a headset allowing blind subjects injected with a light-sensitive virus to develop a kind of "super-sight" sensitive to spectrums that ordinary vision cannot detect.

superflux.in @anabjain

Garry Kasparov

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Garry Kasparov

Grandmaster, analyst

Garry Kasparov is esteemed by many as the greatest chess player of all time. Now he's engaged in a game with far higher stakes: the preservation of democracy.

When 22-year-old Garry Kasparov became the world's youngest chess Grand Champion, few could predict his turbulent career in chess or as a dissident. His chessboard wizardry was already the stuff of legend when, in 1997, he made headlines when he lost a rematch to IBM's Deep Blue supercomputer, ushering AI into the public sphere.

Kasparov's book *Winter Is Coming* details the rise of Putin's Russia as well as Kasparov's persecution and self-exile, and it serves chilling warnings of reactionary forces gathering in the West. He is the chair of the Human Rights Foundation, succeeding his predecessor Vaclav Havel.

kasparov.com @Kasparov63

Laura Galante

Cyberspace analyst

Laura Galante analyzes how states use cyberspace: a domain where militaries, intelligence services, criminal groups and individuals pursue their interests with far fewer restraints than in the physical world.

At FireEye, Galante's teams have profiled advanced cyber threats, investigated network breaches and portrayed the political, military and financial implications of cyber operations. Part of the original Mandiant Intelligence team, Galante has led strategic analysis, developed intelligence capabilities and offerings, and directed publications including *APT28: A Window into Russia's State Cyber Espionage*; *Red Line Drawn: China Recalculates its Use of Cyber Espionage*; and *Hacking the Street? FIN4 Likely Playing the Market* among others.

In November 2016 she spoke at the UN Security Council's Arria Formula meeting on cybersecurity and international peace and security. She frequently appears on and provides commentary to: CNN, Bloomberg, NPR, BBC, Fox News, the *New York Times*, *The Financial Times*, *The Wall Street Journal*, Reuters, the Associated Press and other global and industry media. Prior to her work at FireEye and Mandiant, Galante led a contractor team analyzing cyber capability development and military doctrine at the US Department of Defense. She supported the 2010 US-Russia bilateral information security talks.

fireeye.com @LauraJGalante

OK Go

Band

A wildly creative band of music- and video-makers, OK Go is building a media empire on the back of endless, boundless ingenuity.

With a career that includes award-winning videos, *New York Times* op-eds, a major label split and the establishment of a DIY trans-media mini-empire (Paracadute), collaborations with pioneering dance companies and tech giants, animators and Muppets, and an experiment that aims to encode Hungry Ghosts on actual strands of DNA, OK Go continue to fearlessly dream and build new worlds in a time when creative boundaries have all but dissolved.

The band has been honored with a Grammy, three MTV Video Music Awards (one of them from Japan!), a CLIO, three UK Music Video Awards, two Webby Awards (including one for their collaboration with The Muppets and Sesame Street) and a spot in a Guggenheim installation. Their latest video is "The One Moment," directed by the band's singer, Damian Kulash Jr.

okgo.net @okgo

Tim Ferriss

Human guinea pig, author

Tim Ferriss is author of "The 4-Hour Workweek," a self-improvement program of four steps: defining aspirations, managing time, creating automatic income and escaping the trappings of the 9-to-5.

Tim Ferris brings an analytical yet accessible approach to the challenges of self-improvement and career advancement through what he calls "lifestyle design." His 2007 book, *The 4-Hour Workweek*, and his lectures on productivity are stuffed with moving, encouraging anecdotes -- often from his own life -- that show how simple decisions, made despite fears or hesitation, can make for a drastically more meaningful day-to-day experience at work, or in life.

Word-of-blog chatter in Silicon Valley may have propelled his book to bestselling success, but Ferriss himself takes a fervid stance against the distractions of technology toys that promote unnecessary multitasking. Following the success of his book, Ferriss has become a full-time angel investor.

Titus Kaphar

Artist

Titus Kaphar's artworks interact with the history of art by appropriating its styles and mediums.

As Titus Kaphar says of his work: "I've always been fascinated by history: art history, American history, world history, individual history -- how history is written, recorded, distorted, exploited, reimagined, and understood. In my work I explore the materiality of reconstructive history. I paint and I sculpt, often borrowing from the historical canon, and then alter the work in some way. I cut, crumple, shroud, shred, stitch, tar, twist, bind, erase, break, tear, and turn the paintings and sculptures I create, reconfiguring them into works that nod to hidden narratives and begin to reveal unspoken truths about the nature of history."

His latest works are an investigation into the highest and lowest forms of recording history. From monuments to mug shots, this body of work exhibited at Jack Shainman gallery December-January 2017 seeks to collapse the line of American history to inhabit a fixed point in

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the present. Historical portraiture, mug shots, and YouTube stills challenge viewers to consider how we document the past, and what we have erased. Rather than explore guilt or innocence, Kaphar engages the narratives of individuals and how we as a society manage and define them over time. As a whole, this exhibition explores the power of rewritten histories to question the presumption of innocence and the mythology of the heroic.

kapharstudio.com

Rabbi Lord Jonathan Sacks

Religious leader

In a world violently polarized by extremists, Rabbi Lord Jonathan Sacks is proposing and advocating solutions to mounting religious intolerance.

Rabbi Lord Sacks is one of Judaism's spiritual leaders, and he exercises a primary influence on the thought and philosophy of Jews and people of all faiths worldwide. Since stepping down as Chief Rabbi of the UK and Commonwealth in 2013, Rabbi Lord Sacks has become an increasingly well-known speaker, respected moral voice and writer; his 2015 book is *Not in God's Name: Confronting Religious Violence*.

Granted a seat in the British House of Lords in 2009, Rabbi Lord Sacks is a key Jewish voice for universalism and an embrace of tolerance between religions and cultures. He rejects the "politics of anger" brought about by the way "we have acted as if markets can function without morals, international corporations without social responsibility and economic systems without regard to their effect on the people left stranded by the shifting tide." He also sees, as a key idea for faith in our times, that unity in heaven creates diversity on earth.

rabbisacks.org @rabbisacks

Tuesday, April 25, 8:30AM - 10:15AM PDT

Session 2: Our Robotic Overlords

Hosted by Chris Anderson and Helen Walters.

Marc Raibert

Roboticist

Marc Raibert is the founder and CEO of robot maker Boston Dynamics.

Working with his team at Boston Dynamics, Marc Raibert builds some of the world's most advanced robots, such as BigDog, Atlas, Spot and Handle. These robots are inspired by the remarkable ability of animals to move with agility, dexterity, perception and intelligence. A key ingredient of these robots is their dynamic behavior, which contributes to their lifelike qualities and their effectiveness in the real world.

Raibert founded Boston Dynamics as a spinoff from MIT, where he ran the Leg Laboratory, which helped establish the scientific basis for highly dynamic robots. He was a professor of EE&CS at MIT and before that associate professor of CS & Robotics at Carnegie Mellon University. Raibert is a member of the National Academy of Engineering.

bostondynamics.com

Noriko Arai

AI expert

Could an AI pass the entrance exam for the University of Tokyo? Noriko Arai oversees a project that wants to find out.

Noriko Arai is the program director of an AI challenge, Todai Robot Project, which asks the question: Can AI get into the University of Tokyo? The project aims to visualize both the possibilities and the limitation of current AI by setting a concrete goal: a software system that can pass university entrance exams. In 2015 and 2016, Todai Robot achieved top 20 percent in the exams, and passed more than 60 percent of the universities in Japan.

The inventor of Reading Skill Test, in 2017 Arai conducted a large-scale survey on reading skills of high and junior high school students with Japan's Ministry of Education. The results revealed that more than half of junior high school students fail to comprehend sentences sampled from their textbooks. Arai founded the Research Institute of Science for Education to elucidate why so many students fail to read and how she can support them.

nii.ac.jp/en/faculty/society/arai_noriko researchmap.jp/arai_noriko/english

Stuart Russell

AI expert

Stuart Russell wrote the standard text on AI; now he thinks deeply on AI's future -- and the future of us humans too.

Stuart Russell is a professor (and formerly chair) of Electrical Engineering and Computer Sciences at University of California at Berkeley. His book *Artificial Intelligence: A Modern Approach* (with Peter Norvig) is the standard text in AI; it has been translated into 13 languages and is used in more than 1,300 universities in 118 countries. His research covers a wide range of topics in artificial intelligence including machine learning, probabilistic reasoning, knowledge representation, planning, real-time decision making, multitarget tracking, computer

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vision, computational physiology, global seismic monitoring and philosophical foundations.

He also works for the United Nations, developing a new global seismic monitoring system for the nuclear-test-ban treaty. His current concerns include the threat of autonomous weapons and the long-term future of artificial intelligence and its relation to humanity.

eecs.berkeley.edu/~russell

Joseph Redmon

Computer scientist

Joseph Redmon works on the YOLO algorithm, which combines the simple face detection of your phone camera with a cloud-based AI -- in real time.

Computer scientist Joseph Redmon is working on the YOLO (You Only Look Once) algorithm, which has a simple goal: to deliver image recognition and object detection at a speed that would seem science-fictional only a few years ago. The algorithm looks like the simple face detection of a camera app but with the level complexity of systems like Google's Deep Mind Cloud Vision, using Convolutional Deep Neural Networks to crunch object detection in realtime. It's the kind of technology that will be embedded on all smartphones in the next few years.

Redmon is also internet-famous for his resume.

pjreddie.com @pjreddie

Tom Gruber

AI developer

As co-creator of Siri, Tom Gruber helped redefine the role of machine intelligence in our lives and transformed the way we interact with our devices.

By connecting humans and machines with AI, designer, inventor and polymath Tom Gruber is opening up new ways to improve our lives and augment human intelligence.

Gruber led the team that revolutionized human-machine interaction with Siri, the intelligent personal assistant that can understand your spoken language and help you get things done. Launched in 2010, Siri is now used billions of times a week in more than 30 countries around the world.

tomgruber.org

Radhika Nagpal

Robotics engineer

Taking cues from bottom-up biological networks like those of social insects, Radhika Nagpal helped design an unprecedented “swarm” of ant-like robots.

With a swarm of 1,024 robots inspired by the design of ant colonies, Radhika Nagpal and her colleagues at Harvard’s SSR research group have redefined expectations for self-organizing robotic systems. Guided by algorithms, Nagpal’s shockingly simple robots guide themselves into a variety of shapes -- an ability that, brought to scale, might lead to applications like disaster rescue, space exploration and beyond.

In addition to her work with biologically inspired robots, Nagpal helped create ROOT, a simple robot to teach coding to would-be programmers through a simple user interface suitable for students of all ages.

radhikanagpal.org eecs.harvard.edu/ssr

Tuesday, April 25, 11:00AM - 12:45PM PDT

Session 3: The Human Response

Hosted by Chris Anderson and Kelly Stoetzel.

Rutger Bregman

Historian

Rutger Bregman is the author of the new "Utopia for Realists."

Rutger Bregman is one of Europe’s most prominent young thinkers. The 28-year-old historian and author has published four books on history, philosophy and economics. His *History of Progress* was awarded the Belgian Liberales prize for best nonfiction book of 2013. The Dutch edition of *Utopia for Realists* became a national bestseller and will be translated in 16 languages this year. Bregman has twice been nominated for the prestigious European Press Prize for his journalism work at *The Correspondent*. His work has been featured in The *Washington Post* and *The Guardian* and on the BBC.

rutgerbregman.com @rcbregman

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Martin Ford

Futurist

Martin Ford imagines what the accelerating progress in robotics and artificial intelligence may mean for the economy, job market and society of the future.

Martin Ford was one of the first analysts to write compellingly about the future of work and economies in the face of the growing automation of everything. He sketches a future that's radically reshaped not just by robots but by the loss of the income-distributing power of human jobs. How will our economic systems need to adapt?

He's the author of two books: *Rise of the Robots: Technology and the Threat of a Jobless Future* (winner of the 2015 Financial Times/McKinsey Business Book of the Year Award) and *The Lights in the Tunnel: Automation, Accelerating Technology and the Economy of the Future*, and he's the founder of a Silicon Valley-based software development firm. He has written about future technology and its implications for the *New York Times*, *Fortune*, *Forbes*, *The Atlantic*, *The Washington Post*, *Harvard Business Review* and *The Financial Times*.

mfordfuture.com @MFordFuture

Jack Conte

Musician, entrepreneur

With his membership platform Patreon, YouTube star Jack Conte may have solved a perennial problem of content creators -- getting paid for digital media.

As a solo artist and member of folk-rock duo Pomplamoose, Jack Conte garnered millions of views for his offbeat "video songs," including his breakout hit "Yeah Yeah Yeah" and "Pedals," a robotic tour-de-force with a set that duplicates the cockpit of the Millennium Falcon.

Despite his success, Conte noted the disconnect between page views and revenue, and realized that if you're a widely viewed artist and you aren't making money, "that's not your fault -- it's technology's fault." His solution is Patreon: a membership platform built on recurring payments from patrons to support creatives with ongoing projects.

patreon.com/jackconte @jackconte

Sara DeWitt

Children's media expert

Like Mister Rogers before her, Sara DeWitt strives to make every child feel special by charting the forefront of new digital mediums where kids spend their time.

Sara DeWitt's vision seems simple: make each digital interaction an opportunity to learn and delight in new discoveries. How does that vision come to light as kids access technology at younger ages than ever before?

Over the past 18 years, DeWitt has worked at the forefront of new platforms in an effort to be everywhere kids are -- now she's at PBS Kids Digital, building award-winning sites, games and apps. As more media outlets try to capture the interest of our youngest audiences, her research on how digital spaces affect skills and social emotional development in kids is more relevant than ever.

pbskids.org @saradewitt

Ray Dalio

Hedge fund chair

Ray Dalio is the founder, chair and co-chief investment officer of Bridgewater Associates, a global leader in institutional portfolio management and the largest hedge fund in the world.

Dalio started Bridgewater out of his two-bedroom apartment in New York City in 1975 and has grown it into the fifth most important private company in the U.S. (according to *Fortune* magazine). Because of the firm's many industry-changing innovations over its 40-year history, he has been called the "Steve Jobs of investing" by *aiCIO* magazine and named one of *TIME* magazine's "100 Most Influential People."

Dalio attributes Bridgewater's success to its unique culture. He describes it as "a believability-weighted idea meritocracy" in which the people strive for "meaningful work and meaningful relationships through radical truth and radical transparency." He has explained this approach in his book *Principles*, which has been downloaded more than three million times and has produced considerable curiosity and controversy.

bridgewater.com principles.com

Anthony D. Romero

Attorney, public-interest activist

Anthony D. Romero is the executive director of the American Civil Liberties Union (ACLU).

The ACLU is dedicated to defending liberty and individual freedom in the US -- which is an interesting mandate to have right now. Anthony Romero has headed the organization since 2001, focusing on building capacity in order to defend the laws that protect Americans' freedoms.

Under Romero's watch, the ACLU launched its national "Keep America Safe and Free" campaign to protect basic freedoms during a time of crisis; launched its unique legal challenge to the patents held by a private company on the human genes associated with breast and ovarian cancer; launched litigation and lobbying efforts to win the freedom to marry for same-sex couples; and filed the first lawsuit against President Trump's Muslim Ban.

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aclu.org

T. Morgan Dixon

Health activist

T. Morgan Dixon is the co-founder and CEO of GirlTrek, inspiring nearly 100,000 neighborhood walkers.

T. Morgan Dixon co-leads GirlTrek, the largest public health nonprofit for African-American women and girls in the United States. GirlTrek encourages women to use walking as a practical first step to inspire healthy living, families and communities and knits local advocacy together to lead a civil rights-inspired health movement that seeks to eliminate barriers to physical activity, improve access to safe places to walk, protect and reclaim green spaces and improve the walkability and built environments of 50 high-need communities across the United States.

Prior to GirlTrek, Dixon was on the front lines of education reform. She served as Director of Leadership Development for one of the largest charter school networks in the country, Achievement First, and directed the start-up of six public schools in New York City for St. Hope and the Urban Assembly, two organizations funded by the Bill & Melinda Gates Foundation. As the leader of GirlTrek, Morgan received fellowships from Echoing Green (2013), Ashoka (2014) and The Aspen Institute (2015).

girltrek.org @GirlTrek

Vanessa Garrison

Health activist

As COO of GirlTrek, Vanessa Garrison encourages African American women and girls to get out and take a walk.

Vanessa Garrison is the co-founder and COO of GirlTrek, the largest public health nonprofit for African-American women and girls in the United States. With nearly 100,000 neighborhood walkers, GirlTrek encourages women to use walking as a practical first step to inspire healthy living, families and communities.

Working with partners, GirlTrek has developed a world-class training for African-American women to serve as health professionals in the

areas of fitness, mental health, nutrition, and environmental stewardship. Prior to GirlTrek, Garrison worked as a Program Coordinator for Our Place DC, a nonprofit organization that provides services to currently and formerly incarcerated women. In her work with GirlTrek, she's received fellowships from Echoing Green and The Aspen Institute and been named "Health Hero" by Essence Magazine.

girltrek.org @GirlTrek

Tuesday, April 25, 2:15PM - 4:00PM PDT

TED en Español: Conexión y Sentido

Hosted by Gerry Garbulsky, TED en Español showcases powerful ideas in Spanish. Join us in the Community Theater. (English translation will be available.)

Gabriela González

Astrophysicist

Gabriela González is part of the collaboration of more than 1,000 scientists who measured for the first time the gravitational waves that Einstein predicted over 100 years ago.

Over 100 years after Albert Einstein predicted gravitational waves -- ripples in space-time caused by violent cosmic collision, like the merging of two black holes -- the LIGO Scientific Collaboration confirmed their existence using large, hyper-sensitive detectors in different parts of the world. As LIGO's former spokesperson and the person responsible for the collaboration of 90 international scientific institutions that the project entailed, Argentine astrophysicist Gabriela González announced the extraordinary discovery to the world in 2016.

A relentless curiosity about the universe led González to astrophysics as a teenager. Over the course of her 25-year career, she has advanced the field of gravitational wave detection, working on both improving the sensitivity of interferometers and data analysis. She is the recipient of the E. Bouchet and the Jesse W. Beams awards from the American Physical Society, the B. Rossi prize from the American Astronomical Society, and the 2016 Scientific Discovery Award from the US National Academy of Sciences. She was the first woman to receive a full professorship in the physics department at Louisiana State University.

phys.lsu.edu/faculty/gonzalez/

Jorge Drexler

Musician, poet

Jorge Drexler is a musician and the first Uruguayan to win an Oscar. His music plays with genre and influence, combining subtle harmonies and regional styles with electronic effects.

Jorge Drexler doesn't lay claim to one identity over another. Born to a German-Jewish exile, Drexler grew up between Uruguay and Israel, traveled widely across Latin America, and eventually settled in Spain. Within his music, you can hear touches of milonga and bossa nova and even Bach, as his lyrics wrangle with notions of nationality and belonging, language, identity and love.

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Like both of his parents, Drexler started his career as a physician, but at the age of 30, he decided to pursue music full-time. The release of his fifth album, Frontera, caught the attention of Brazilian director Walter Salles, who tapped him to write the closing song for the 2004 film *Motorcycle Diaries*. Titled "Al Otro Lado del Río" (The Other Side of the River), the song won Drexler an Academy Award for Best Original Song and propelled him into the international spotlight.

Over the course of his 25-year career, Jorge Drexler has produced 12 albums, received 15 Latin Grammy nomination (with two wins in 2014 Record of the Year and Best Singer-Songwriter Album), four US Grammy nominations, 5 ASCAP Latin Awards, and one Academy Award. He has also collaborated with musicians from Shakira to Mercedes Sosa to Neneh Cherry and Jovanotti.

jorgedrexler.com @drexlerjorge

Jorge Ramos

Journalist, news anchor

Jorge Ramos is a journalist and a news anchor. His work covers the issues that affect the 55 million Latinos in the United States and immigrants all over the world.

Jorge Ramos immigrated to the United States from Mexico City, on a student visa at the age of 24. What started as a street beat for a local Spanish-language broadcast in Los Angeles in the 1980s has evolved into a career of remarkable distinction and credibility. Today, Ramos co-anchors Univision's flagship Spanish-language broadcast, "Noticiero Univisión," writes a nationally syndicated column, hosts the Sunday Morning show "Al Punto" and now, the English language program, "America with Jorge Ramos." He is the winner of eight Emmys and the author of eleven books, including *Take a Stand: Lessons from Rebels*, 2016; *A Country for All: An Immigrant Manifesto*; and *Dying to Cross: The Worst Immigrant Tragedy in American History*.

In the absence of political representation in the United States, Jorge Ramos gives a face and voice to the millions of Latinos and immigrants living in the United States. He uses his platform to promote open borders and immigrants' rights and demands accountability from the world leaders he interviews. Nearly 1.9 million viewers tune into his program each night, and in 2015, Time named him one of "The World's 100 Most Influential People."

jorgeramos.com @jorgeramosnews

Isabel Behncke Izquierdo

Primatologist

Isabel Behncke Izquierdo studies the social behavior of primates and the birth of human cultures.

TED Fellow Isabel Behncke Izquierdo writes: I was born and raised in Chile, and was educated in animal behaviour and evolutionary anthropology in Cambridge and Oxford. For my PhD work, I study the social behaviour (and play behaviour in particular) of wild bonobos in DR Congo.

Bonobos are, together with chimpanzees, our living closest relatives; however we know very little about them -- mostly through captive work. In Wamba, a most remote jungle location, I have observed unique aspects of bonobo lives (from imaginary play and laughter to inter-group encounters to accidents and death) that challenge and illuminate our understanding of human evolution. I aim to link the play of adult bonobos to insights on human laughter, joy, creativity and our capacity for wonder and exploration.

Tomás Saraceno

Artist

Tomás Saraceno is an artist who invites us to consider the impossible, like spiders that play music or cities in the sky.

Tomás Saraceno's soaring artworks inspire human dreams and point to a world free of our earth-bound afflictions, whether by suspending its viewers in webs high above gallery floors or by casting solar-powered baloons adrift in the stratosphere -- or turning spiders into music-makers.

Part art project and science experiment, his latest work *Aerocene* bypasses the museum in favor of an unprecedented airborne journey. Using only the heat of the sun and wind for its locomotion, *Aerocene* not only shattered solar-powered flight records but also invites others to hack its open-source, interactive design and model its flight behavior.

tomassaraceno.com @tomassaraceno

Ingrid Betancourt

Writer, peace advocate

Ingrid Betancourt was a presidential candidate in Colombia in 2002 when she was kidnapped by guerilla rebels. After six years in captivity and a high-profile rescue, she now writes about what she learned about fear, forgiveness and the divine.

In 2002, the Colombian rural guerilla movement known as the FARC (Revolutionary Armed Forces of Colombia) kidnapped Ingrid Betancourt in the middle of her presidential campaign. For the next six years, Betancourt was held hostage in jungle prison camps where she was ravaged by malaria, fleas, hunger, and human cruelty until her high-profile rescue by the Colombian government in 2008.

But Betancourt's captivity did not diminish her sensitivity to the world. Since her release, the would-be president has become a memoirist and fiction writer. Her first book, *Even Silence Has Its End*, which lyrically recounts her six years in the impenetrable jungle, was published in 2010. In 2016, she published a second work -- this time of fiction -- called *The Blue Line*, about the disappearances in Argentina during the Dirty War from 1976 to 1983.

Betancourt has received multiple international awards for her commitment to democratic values, freedom and tolerance, including the French National Order of the Légion d'Honneur, the Spanish Prince of Asturias Prize of Concord, and the Italian Prize Grinzane Cavour.

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She remains a vocal proponent of peace negotiations between the Colombian government and the FARC.

Tuesday, April 25, 5:00PM - 7:00PM PDT

Session 4: Health, Life, Love

Hosted by Chris Anderson, Anna Verghese and Bruno Giussani.
Not attending TED2017? Watch Session 4 – TED Prize – broadcast to cinemas! Find showtimes

Serena Williams

Athlete

With her legendary spirit and unstoppable serve, tennis legend Serena Williams has become one of the world's most enduring athletic superstars.

Serena Williams sits at the top of the tennis world; she's won 23 career Grand Slams, which is the most Grand Slam singles titles in history, with her most recent win at the 2017 Australian Open. In some analysts' eyes, she's quite simply the greatest athlete of all time.

But Williams has extended her influence far beyond the tennis court. Through her activism, high-profile endorsements, TV and film appearances and writing (including a guide to life written with her sister, Venus), Williams inspires millions of fans worldwide.

serenawilliams.com @serenawilliams on Instagram

Gayle King

Journalist

Gayle King is a co-host of "CBS This Morning" and Editor-at-Large of the award-winning O, the Oprah Magazine.

An award-winning journalist who has worked across television, radio and print, Gayle King is a co-host of *CBS This Morning* and Editor-at-Large of *O, the Oprah Magazine*.

King previously hosted *The Gayle King Show*, a live, weekday television interview program on OWN: The Oprah Winfrey Network. The program, which featured a discussion of a broad variety of topics that include politics, cultural developments, was also broadcast on XM Satellite Radio, where it premiered in 2006.

Before moving into print and radio, King worked for 18 years (1982–2000) as a television news anchor for CBS affiliate WFSB-TV in Hartford, Conn., during which period, she also hosted her own syndicated daytime program. Prior to joining WFSB, King worked at several other television stations, including WDAF-TV in Kansas City, Mo. (1978-1981), WJZ-TV in Baltimore, Md. (1976), and WTOP-TV in Washington, D.C. (1975).

King has received numerous awards for her extensive work as a journalist. In addition to three Emmys, she was honored in 2008 with the American Women in Radio & Television Gracie Award for Outstanding Radio Talk Show and in 2010 with both the Individual Achievement Award for Host-Entertainment/Information and the New York Women in Communications' Matrix Award.

cbsnews.com/cbs-this-morning @GayleKing

Atul Gawande

Surgeon, journalist

Surgeon by day and public health journalist by night, Atul Gawande explores how doctors can dramatically improve their practice using something as simple as a checklist.

Atul Gawande is author of several best-selling books, including *Complications: A Surgeon's Notes on an Imperfect Science*, *Better: A Surgeon's Notes on Performance*, *Being Mortal: Medicine and What Matters in the End* and *The Checklist Manifesto*.

He is also a surgeon at Brigham and Women's Hospital in Boston, a staff writer for *The New Yorker* and a professor at Harvard Medical School and the Harvard School of Public Health. He has won the Lewis Thomas Prize for Writing about Science, a MacArthur Fellowship and two National Magazine Awards. In his work in public health, he is Executive Director of Ariadne Labs, a joint center for health systems innovation and chair of Lifebox, a nonprofit organization making surgery safer globally.

Photo: Aubrey Calo

atulgawande.com ariadnelabs.org

Anna Rosling Rönnlund

Co-founder of Gapminder

Anna Rosling Rönnlund's personal mission: to make it easy for anyone to understand the world visually.

Always with the end consumer at heart, Anna Rosling Rönnlund spends her days making sure everything at Gapminder -- a site she cofounded with Hans and Ola Rosling -- is easy to use and easy to understand. On Gapminder, users can explore data and statistics about the world -- and, just maybe, upend their worldview.

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Passionate about the visual side of data, she invented the project Dollar Street, where she uses photos as data to examine stereotypes about countries, incomes and families around the world -- like, for instancee the wide range of things that people use as toothbrushes.

gapminder.org

The Surprise Guest

World figure

A world figure whose identity we can't yet reveal.

Jon Boogz

Movement artist

Jon Boogz is a movement artist, choreographer, and director who seeks to push the evolution of what dance can be.

As a dancer and creator, Jon Boogz seeks to share with audiences of all backgrounds an appreciation of the melding of art forms while inspiring and bringing awareness to social issues. Boogz recently wrote, choreographed, directed and danced in *Color of Reality*, a short film in collaboration with visual artist Alexa Meade and fellow dancer Lil Buck.

First motivated to dance by the work of Michael Jackson, Boogz has choreographed for icons including Mikhail Baryshnikov, Naomi Campbell, Gloria Estefan; for Pharrell's Adidas Originals campaign to creative direct, choreograph, and perform in Movement Art Is: Standing Rock at ComplexCon; and as creative consultant for ads launching campaigns for Apple and Lexus. Boogz's collaborators include TriBeCa Film Festival, DAIS, Lil Buck, and Flying Lotus; his choreography is used in FOX's *So You Think You Can Dance* and Cirque du Soleil's *MJ ONE*; and he was featured at the Geffen Playhouse's "Backstage at the Geffen" with his dance company Control Freakz, Lil Buck, and spoken-word artist Robin Sanders to honor Morgan Freeman and Jeff Skoll.

jonboogz.com @jonboogz

Lil Buck

Dancer, choreographer, educator

A viral video star known for his gravity-defying, elegant street dance moves, Lil Buck is a fertile collaborator across disciplines and media.

International phenomenon Lil Buck began jookin' -- a street dance that originated in Memphis -- at age 13 alongside mentors Marico Flake and Daniel Price. After receiving early hip-hop training from Teran Garry and ballet training on scholarship at the New Ballet Ensemble, he performed and choreographed until relocating to Los Angeles in 2009.

Named one of *Dance Magazine*'s "25 to Watch," his collaboration with Spike Jonze and Yo-Yo Ma performing *The Swan* went viral in 2011. Since then, he has collaborated with a broad spectrum of artists including JR, Damian Woetzel, the New York City Ballet, Madonna, Benjamin Millepied and Spike Lee. Buck is an avid arts education advocate, a recipient of the WSJ Innovator Award and recently launched a capsule collection with Versace.

youtube.com/user/LILBUCKDALEGEND https://twitter.com/lilbuckdalegend

Raj Panjabi

Physician

A billion people around the world lack access to health care because they live too far from a clinic. Through Last Mile Health, 2017 TED Prize winner Raj Panjabi aims to extend health services to all -- by training members of the community.

Raj Panjabi was nine years old when civil war broke out in his native country of Liberia. His family fled, eventually resettling in High Point, North Carolina. Raj dreamed of going to medical school and, as a student in 2005, he returned to Liberia. He was shocked to find a health care system in total devastation. Only 50 doctors remained to treat a population of four million.

With a small team of Liberian civil war survivors, American health workers and $6,000 he'd received as a wedding gift, Panjabi co-founded Last Mile Health in 2007. Initially focused on care for HIV patients, Last Mile Health has grown into a robust organization that partners with the government of Liberia to recruit, train, equip and employ community health care workers who provide a wide range of services to their neighbors in Liberia's most remote regions. In 2016, Last Mile Health workers treated 50,000 patients, including nearly 22,000 cases of malaria, pneumonia and diarrhea in children. While the organization focuses on integrated primary care, its network can be leveraged in a crisis. In the fight against Ebola, Last Mile Health supported government response by training 1,300 health workers in southeastern Liberia.

Panjabi is a physician in the Division of Global Health Equity at Harvard Medical School, Brigham and Women's Hospital and an advisor to the Clinton Global Initiative. He was ranked as one of "The World's 50 Greatest Leaders" by *Fortune* in 2015 and named to *TIME*'s list of the "100 Most Influential People in the World" in 2016. As the winner of the 2017 TED Prize, he has a bold wish to take his work even further.

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Wednesday, April 26, 8:30AM - 10:15AM PDT

Session 5: Mind, Meaning

Hosted by Helen Walters.

Michael Patrick Lynch

Philosopher

Michael Patrick Lynch examines truth, democracy, public discourse and the ethics of technology in the age of big data.

Michael Patrick Lynch is a writer and professor of philosophy at the University of Connecticut, where he directs the Humanities Institute. His work concerns truth, democracy, public discourse and the ethics of technology. Lynch is the author or editor of seven books, including *The Internet of Us: Knowing More and Understanding Less in the Age of Big Data*, *In Praise of Reason: Why Rationality Matters for Democracy*, *Truth as One and Many* and the New York Times Sunday Book Review Editor's pick, *True to Life*.

The recipient of the Medal for Research Excellence from the University of Connecticut's College of Liberal Arts and Sciences, he is The Principal Investigator for Humility & Conviction in Public Life, a $7 million project aimed at understanding and encouraging meaningful public discourse funded by the John Templeton Foundation and the University of Connecticut. He's a frequent contributor to the New York Times "The Stone" blog.

michael-lynch.philosophy.uconn.edu

Dan Ariely

Behavioral economist

The dismal science of economics is not as firmly grounded in actual behavior as was once supposed. In "Predictably Irrational," Dan Ariely told us why.

Dan Ariely is a professor of psychology and behavioral economics at Duke University and a founding member of the Center for Advanced Hindsight. He is the author of the bestsellers *Predictably Irrational*, *The Upside of Irrationality*, and *The Honest Truth About Dishonesty* -- as well as the TED Book *Payoff: The Hidden Logic that Shapes Our Motivations*.

Through his research and his (often amusing and unorthodox) experiments, he questions the forces that influence human behavior and the irrational ways in which we often all behave.

predictablyirrational.com @danariely

Mariano Sigman

Neuroscientist

In his provocative, mind-bending book "The Secret Life of the Mind," neurologist Mariano Sigman reveals his life's work exploring the inner workings of the human brain.

Mariano Sigman, a physicist by training, is a leading figure in the cognitive neuroscience of learning and decision making. He is the founder of the Integrative Neuroscience Laboratory at the University of Buenos Aires. Sigman was awarded a Human Frontiers Career Development Award, the National Prize of Physics, the Young Investigator Prize of "College de France," the IBM Scalable Data Analytics Award and is a scholar of the James S. McDonnell Foundation. In 2016 he was made a Laureate of the Pontifical Academy of Sciences.

In *The Secret Life of the Mind*, Sigman's ambition is to explain the mind so that we can understand ourselves and others more deeply. He shows how we form ideas during our first days of life, how we give shape to our fundamental decisions, how we dream and imagine, why we feel certain emotions, how the brain transforms and how who we are changes with it. Spanning biology, physics, mathematics, psychology, anthropology, linguistics, philosophy and medicine, as well as gastronomy, magic, music, chess, literature and art, The Secret Life of the Mind revolutionizes how neuroscience serves us in our lives, revealing how the infinity of neurons inside our brains manufacture how we perceive, reason, feel, dream and communicate.

neuro.org.ar @mariuchu

Anika Paulson

Student, musician

Anika Paulson's love for music permeates her understanding of herself, her surroundings and the mysteries that make up the smallest and biggest parts of life.

Whether it's the long trek between high school classes or the exploration of self-identity in college, Anika Paulson's escape is always music. A self-proclaimed nervous Minnesotan, music is the measure of her life's tempo. There's no doubt that whatever Paulson decides to do, she will use the power and metaphor of music to guide her future. After all, according to Paulson, whether it's friendships or string theory, everything is music.

Recently, Paulson completed a TED-Ed Club and was one of 20 students selected to speak at TED-Ed Weekend 2016 at TED's headquarters in New York City.

@_annikap

Lisa Genova

Neuroscientist, novelist

Through her fiction, Lisa Genova beckons us into the lives of people with neurological disease, making their worlds real and relatable.

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Lisa Genova wields her ability to tell a story and her knowledge of the human brain to talk about medical conditions like Alzheimer's in warmly human terms. Her writing, often focusing on those who are misunderstood, explores the lives of people living with neurological diseases and disorders. A bestselling author, her work has been transformed into an Oscar-winning film, *Still Alice*, but the real triumph is Genova's ability to help us empathize with a person's journey we otherwise couldn't even begin to understand.

Her newest book, *Inside the O'Briens*, is about Huntington's disease.

lisagenova.com @LisaGenova

Robin Hanson

Economist, social scientist

Does humanity have a future as uploaded minds? In his work, Robin Hanson asks this and other extra-large questions.

In his book, *The Age of Em: Work, Love and Life When Robots Rule the Earth*, Robin Hanson re-imagines humanity's role as our tech becomes smarter. A pioneer in prediction markets, also known as information markets and idea futures, Hanson has been known since the 1980s for taking the very very long view on topics as varied as (a selected list) spatial product competition, health incentive contracts, group insurance, product bans, evolutionary psychology and bioethics of health care, voter information incentives, incentives to fake expertise, Bayesian classification, agreeing to disagree, self-deception in disagreement, probability elicitation, wiretaps, image reconstruction, the history of science prizes, reversible computation, the origin of life, the survival of humanity, very long term economic growth, growth given machine intelligence, and interstellar colonization.

Meanwhile, he has developed new technologies for conditional, combinatorial, and intermediated trading, and studied insider trading, manipulation and other foul play. Hanson is associate professor of economics at George Mason University, and a research associate at the Future of Humanity Institute of Oxford University. His next book is *The Elephant in the Brain*, co-authored with Kevin Simler, due in 2018.

overcomingbias.com @robinhanson

Anil Seth

Cognitive scientist

How can the "inner universe" of consciousness be explained in terms of mere biology and physics? Cognitive neuroscientist Anil Seth explores the brain basis of consciousness and self.

In his groundbreaking research, Anil Seth seeks to understand consciousness in health and in disease. As founding co-director of the University of Sussex's Sackler Centre for Consciousness Science, his research bridges neuroscience, mathematics, artificial intelligence, computer science, psychology, philosophy and psychiatry. He has also worked extensively with playwrights, dancers and other artists to shape a truly humanistic view of consciousness and self.

Seth is the editor and co-author of the best-selling *30-Second Brain*, a collection of brief and engaging neuroscience vignettes. His forthcoming book *The Presence Chamber* develops his unique theories of conscious selfhood within the rich historical context of the mind and brain sciences.

anilseth.com @anilkseth

Wednesday, April 26, 11:00AM - 12:45PM PDT

Session 6: Planet, Protection

Hosted by Chris Anderson.

Kristin Poinar

Glaciologist

Kristin Poinar uses remote sensing and numerical models to study the interaction of meltwater with ice flow, especially on the Greenland Ice Sheet.

Hidden under many meters of ice, a pool of meltwater lies under the Greenland Ice Sheet. Kristin Poinar studies how the meltwater forms and flows in this dynamic glacial system. She asks: How did this water get there, and where does it go? How much water is in there? And how is climate change affecting this system?

Using data from Operation IceBridge flights and from field instruments, she's building a numerical model of how crevasses form and channel water. In fact, a NASA report released in February 2017 revealed a new pathway her team discovered for meltwater to reach the ocean. Using physically based models to constrain the bounds of what is realistic has shaped Poinar's interest in glaciology.

http://science.gsfc.nasa.gov/sed/bio/kristin.poinar @crevassse

Kate Marvel

Climate scientist

Climate scientist Kate Marvel looks at the big picture of environmental change.

Kate Marvel is a scientist at Columbia University and the NASA Goddard Institute of Space studies. She uses computer models and

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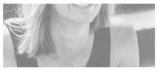

satellite observations to monitor and explain the changes happening around us. Her work has suggested that human activities are already affecting global rainfall and cloud patterns. Marvel is committed to sharing the joy and beauty of science with wider audiences.

She has advised journalists, artists and policymakers, written a popular science blog and given frequent public talks. Her writing has appeared in *Nautilus Magazine*.

marvelclimate.com @DrKateMarvel

Danny Hillis

Computer theorist

Inventor, scientist, author, engineer -- over his broad career, Danny Hillis has turned his ever-searching brain on an array of subjects, with surprising results.

Danny Hillis is an inventor, scientist, author and engineer. While completing his doctorate at MIT, he pioneered the concept of parallel computers that is now the basis for most supercomputers, as well as the RAID array. He holds over 100 US patents, covering parallel computers, disk arrays, forgery prevention methods and various electronic and mechanical devices, and he has recently been working on problems in medicine as well. He is also the designer of a 10,000-year mechanical clock, and he gave a TED Talk in 1994 that is practically prophetic. Throughout his career, Hillis has worked at places like Disney and now Applied Minds, always looking for the next fascinating problem.

appliedminds.com

Tim Kruger

Geoengineering researcher

Tim Kruger researches geoengineering: techniques to counteract climate change by deliberate, large-scale intervention in the earth system, by reflecting sunlight back into space or by reducing the level of carbon dioxide in the atmosphere.

While our first priority should be to reduce global carbon emissions, research into geoengineering could prove vital in the fight to protect our planet. At the Oxford Geoengineering Programme, Tim Kruger aims to assess the range of proposed geoengineering techniques to determine which, if any, could be both technically feasible and benign environmentally, socially and ethically.

Kruger, an Oxford Martin Fellow, is a co-author of the Oxford Principles, a draft code of conduct for geoengineering. It calls for geoengineering to be regulated as a public good, for public participation in decision-making and for disclosure of research and open publication of results. He is involved in developing a process that uses natural gas to generate electricity in a way that removes carbon dioxide from the atmosphere.

geoengineering.ox.ac.uk linkedin.com

Daan Roosegaarde

Artist

With his futuristic artworks, Daan Roosegaarde illuminates the intersection of technology, humanity and our urban environments.

Daan Roosegaarde builds jaw-dropping artworks that redefine humanity's relationship to city spaces. Along with his team at Studio Roosegaarde, Roosegaarde is devoted to "Landscapes of the Future," city prototypes and urban adornments that fuse aesthetics with sustainability.

From Smog Free Project in Beijing -- a tower that purifies its surrounding atmosphere and harvests pollutants to preserve as jewelry -- to an interactive dance floor that generates electricity from dancers, Roosegaarde's designs revolutionize the role of technology in the built environment.

studioroosegaarde.net @SRoosegaarde

Peter Calthorpe

Urban designer

Through his writing and his realized projects, Peter Calthorpe has spread the vision of New Urbanism, a framework for creating sustainable, human-scaled places.

Peter Calthorpe's 30-year design practice is informed by the idea that successful places -- whether neighborhoods, towns, urban districts or metropolitan regions -- must be diverse in uses and users, must be scaled to the pedestrian and human interaction, and must be environmentally sustainable.

In the early 1990s he developed the concept of Transit Oriented Development (described in his book *The Next American Metropolis: Ecology, Community and the American Dream*) -- an idea that is now the foundation of many regional policies and city plans around the world. His 2010 book is *Urbanism in the Age of Climate Change*. Calthorpe Associates' work in Europe, Asia and the Middle East has demonstrated that community design with a focus on sustainability and scale can be adapted throughout the globe. His current work throughout China is focused on developing standards and examples of Low Carbon Cities in Beijing, Chongqing, Kunming, Zhuhai, Jinan and other major cities.

calthorpe.com

David Titley

Meteorologist

Scientists and retired Navy officer Dr. David Titley asks a big question: Could the US military play a role in combating climate change?

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David Titley is a Professor of Practice in Meteorology and a Professor of International Affairs at the Pennsylvania State University. He is the founding director of Penn State's Center for Solutions to Weather and Climate Risk. He served as a naval officer for 32 years and rose to the rank of Rear Admiral. Titley's career included duties as commander of the Naval Meteorology and Oceanography Command; oceanographer and navigator of the Navy; and deputy assistant chief of naval operations for information dominance. He also served as senior military assistant for the director, Office of Net Assessment in the Office of the Secretary of Defense.

While serving in the Pentagon, Titley initiated and led the U.S. Navy's Task Force on Climate Change. After retiring from the Navy, Titley served as the Deputy Undersecretary of Commerce for Operations, the chief operating officer position at the National Oceanic and Atmospheric Administration. Titley serves on numerous advisory boards and National Academies of Science committees, including the CNA Military Advisory Board, the Center for Climate and Security and the Science and Security Board of the Bulletin of the Atomic Scientists. Titley is a fellow of the American Meteorological Society. He was awarded an honorary doctorate from the University of Alaska, Fairbanks.

solutions2wxrisk.psu.edu @dwtitley

Ted Halstead

Policy entrepreneur, climate expert, author

Ted Halstead is breathing new life into US climate policy by mobilizing conservative leaders and CEOs around a breakthrough carbon dividends solution.

When not writing or sailing around the world, Ted Halstead launches cutting-edge think tanks. His first, founded when he was 25, introduced new measures of progress and coordinated the Economists' Statement on Climate Change, signed by 18 Nobel laureate economists. His second, New America, has become one of the most influential think tanks in Washington.

Halstead's newest creation, the Climate Leadership Council, is transforming climate policy and politics by advancing a more effective, popular and equitable climate solution, based on the conservative principles of free markets and limited government. He has published numerous articles in the *New York Times*, *Washington Post*, *Financial Times*, *Fortune*, *Atlantic*, *National Review*, *Los Angeles Times* and *Harvard Business Review*. He has also published two books, including *The Radical Center: The Future of American Politics* (co-authored with Michael Lind).

clcouncil.org @ImTedHalstead

Wednesday, April 26, 5:00PM - 7:00PM PDT

Session 7: Connection, Community

Hosted by Kelly Stoetzel and Bruno Giussani.

Jacob Collier

Musician and artist

Jacob Collier is a one-man audio-visual viral sensation. In his videos, he sings every part, plays every instrument and visualizes every component with a captivating vision.

Jacob Collier is nothing short of prodigious. A two-time Grammy-winning singer, arranger, composer, and multi-instrumentalist, he combines everything from jazz and a cappella to classical and Brazilian music. In 2014, he was discovered by the legendary producer Quincy Jone. Shortly after, Collier began working on his audio-visual live performance vehicle designed and built at MIT.

Since his first video in 2011, Collier has amassed more than 250K international followers and 10 million YouTube views, including on his astounding cover of Stevie Wonder's "Don't You Worry 'Bout a Thing." In July 2016, Collier released his chart-topping debut album, *In My Room*. Most recently, he's been touring the world with his unique one-man show, helping to score the newest Dreamworks film, *The Boss Baby*, with Hans Zimmer, collaborating on Herbie Hancock's upcoming record and holding masterclasses at universities across the globe.

jacobcollier.co.uk @JCollierMusic

Anna Heringer

Architect

Anna Heringer's sustainable designs lend breathtaking forms to easily-available local materials while developing the skills and consciousness of their builders.

Before she became an architect, a visit to a small village in Bangladesh immediately hooked Anna Heringer on an ancient and yet neglected building material -- earth. With its easy availability, durability and endless recyclability, she realized, there was a reason its use has persisted for thousands of years.

Since then, Heringer's love affair with sustainable materials has deepened, resulting in acclaimed projects like woven bamboo hostels in China and the METI Handmade School in Rudrapur, where, along with local workers and schoolchildren, she created a building that drew on locally abundant materials and fostered modern, sustainable building skills in local craftsmen. In the 2014 book, *The Future of Architecture*, she and her coauthors argue for a future that is low-impact and adaptable.

anna-heringer.com @AnnaHeringer

Grace Kim

HOUSE_OVERSIGHT_014963

Architect

Grace H. Kim is an internationally recognized expert in cohousing -- the art and craft of creating communities.

Grace H. Kim is an architect and co-founding principal of Schemata Workshop, an award-winning, 16-person architectural practice with a keen focus on building community and social equity. She brings innovative ideas to her projects that merge client goals and sustainability measures -- such as urban agriculture, modular construction, and a focus on building community.

Kim is also the founder of Capitol Hill Urban Cohousing, a collaborative residential community that includes her street-level office and a rooftop urban farm. She walks the talk of sustainability -- leaving a small ecological footprint while incorporating holistic ideals of social and economic resilience into her daily life.

schemataworkshop.com @GraceKimArch

Devita Davison

Food activist

At FoodLab Detroit, Devita Davison supports local entrepreneurs and imagines a new future for food justice.

Detroit is a legendary food town, and it's thanks to small, locally owned businesses that range from streetside barbecue tents to neighborhood bakeries, shops and delis -- even small farms. At FoodLab Detroit, Devita Davison helps locals with ideas for a food business to take their dreams into delicious reality, by connecting them with business advice, help with compliance and licensing, space in professional kitchens, marketing ideas and more. The nonprofit focuses on entrepreneurs and communities who have been traditionally under-resourced, aiming to build power and resilience for people around the city.

FoodLab's vision is to cultivate, connect and catalyze, to use food as an economic engine, to form a supportive community of entrepreneurs and to make good food a reality for all Detroiters.

On LinkedIn @devitadavison

Karoliina Korppoo

Game designer

Inspired by classic city simulation games, Finnish designer Karoliina Korppoo and her fellow game developers at Colossal Order are infusing a venerable gaming genre with fresh perspectives.

Developed by gaming upstarts Colossal Order and guided by Korppoo as lead designer, *Cities: Skylines* has become the gold standard for city simulation games -- an honor previously held by the genre-defining Sim City.

At the core of Colossal Order's rejuvenated game designs is their dedication to creating an accessible experience for all users, whether through ease of use or by allowing users to suggest their own modifications. As a result, Colossal Order doesn't shy away from game projects that touch on the problems of urbanization, gentrification or the possibilities of servicing a city with nothing but gravel roads.

colossalorder.fi @pelikaroliina

Cathy O'Neil

Mathematician, data scientist

Data skeptic Cathy O'Neil uncovers the dark secrets of big data, showing how our "objective" algorithms could in fact reinforce human bias.

In 2008, as a hedge-fund quant, mathematician Cathy O'Neil saw firsthand how really really bad math could lead to financial disaster. Disillusioned, O'Neil became a data scientist and eventually joined Occupy Wall Street's Alternative Banking Group.

With her popular blog mathbabe.org, O'Neil emerged as an investigative journalist. Her acclaimed book *Weapons of Math Destruction* details how opaque, black-box algorithms rely on biased historical data to do everything from sentence defendants to hire workers. In 2017, O'Neil founded consulting firm ORCAA to audit algorithms for racial, gender and economic inequality.

mathbabe.org @mathbabedotorg

Luma Mufleh

Refugee activist

Luma Mufleh does something revolutionary: she coaches soccer. A Jordanian immigrant and Muslim of Syrian descent, Mufleh is determined to empower refugee children everywhere.

Luma Mufleh works with refugee children from war-torn countries, including Syria, Iraq, Burundi, Afghanistan, Somalia and Sudan. The CEO and Founding Director of Fugees Family, Inc., a nonprofit organization that empowers refugee children to successfully integrate into the United States, Mufleh started as a soccer coach. Her work grew into something much larger, however.

Now, she's part principal, part tutor, the head of the first accredited private school dedicated to refugee education in the country, which encompases a summer camp and a college prep program -- and she's building a community and support network that could be the national model the United States needs.

fugeesfamily.org @fugeesfamily

David Miliband

HOUSE_OVERSIGHT_014964

Refugee advocate

As president of the International Rescue Committee, David Miliband enlists his expert statesmanship in the fight against the greatest global refugee crisis since World War II.

As the son of refugees, David Miliband has first-hand experience with those fleeing conflict and disaster. In 2013, he abandoned a long political career to take the helm of the International Rescue Committee, an NGO committed to emergency and long-term assistance to refugees (and founded at the call of Albert Einstein in 1933).

As a former UK Secretary of State for Foreign Affairs, Miliband is no stranger to cross-border politics. He is a leading voice against recent anti-refugee and immigration measures in the US, where the IRC currently runs resettlement programs in 29 cities.

rescue.org @DMiliband

Thursday, April 27, 11:00AM - 12:45PM PDT

Session 8: Bugs and Bodies

Hosted by Chris Anderson.

Robert Sapolsky

Neuroscientist, primatologist, writer

Robert Sapolsky is one of the leading neuroscientists in the world, studying stress in primates (including humans).

We all have some measure of stress, and Robert Sapolsky explores its causes as well as its effects on our bodies (his lab was among the first to document the damage that stress can do to our hippocampus). In his research, he follows a population of wild baboons in Kenya, who experience stress very similarly to the way humans do. By measuring hormone levels and stress-related diseases in each primate, he determines their relative stress, looking for patterns in personality and social behavior that might contribute. These exercises have given Sapolsky amazing insight into all primate social behavior, including our own.

He has been called "one of the best scientist-writers of our time" by Oliver Sacks. Sapolsky has produced, in addition to numerous scientific papers, books for broader audiences, including *A Primate's Memoir: A Neuroscientist's Unconventional Life Among the Baboons*, *Why Zebras Don't Get Ulcers: Stress Disease and Coping*, and *The Trouble with Testosterone*.

profiles.stanford.edu/robert-sapolsky

Jun Wang

Genomics researcher

At his new institute/company, iCarbonX, Wang Jun aims to establish a big data platform for genomics.

In 1999, Wang Jun founded the Bioinformatics Department of Beijing Genomics Institute (BGI, now known as BGI Shenzhen), one of China's premier research facilities. Until July 2015, Wang led the institution of 5,000+ people engaged in studies of genomics and its informatics, including genome assembly, annotation, expression, comparative genomics, molecular evolution, transcriptional regulation, genome variation analysis, database construction as well as methodology development such as the sequence assembler and alignment tools. He also focuses on interpretation of the definition of "gene" by expression and conservation study. The Pig Genome Project was completed at BGI under his leadership, as well as the chicken genome variation map and the TreeFam in collaboration with the Sanger Institute. Recently, he and his group finished the first Asian diploid genome, the 1000 genome project, and many more projects.

In late 2015, Wang founded a new institute/company, iCarbonX, aiming to develop an artificial intelligence engine to interpret and mine genomic data and help people better manage their health and defeat disease.

Anne Madden

Microbial researcher

Whether brewing better beer or chronicling the lives of the microbes living in the dust under the couch, Dr. Anne Madden seeks to understand and utilize the microbial world around us.

Along with her colleagues in the Laboratory of Rob Dunn at North Carolina State University, Anne Madden studies ways that our dimly understood microbial neighbors can yield surprising discoveries. She's helped create one of the first single-culture sour beers, discovered a new fungus living inside wasp nests and cataloged the astonishing diversity of some of the microscopic and macroscopic life in our homes -- more than 600 species of arthropods in USA homes at last count.

In addition to her research work at North Carolina State University, Madden is Chief Strategist at the brewing yeast company Lachancea LLC and consults for a variety of industries from bee keeping companies to technology firms. Her work has been featured on numerous media platforms, including *National Geographic* and *Newsweek*.

anneamadden.com @anneamadden

David Brenner

Radiation scientist

HOUSE_OVERSIGHT_014965

David Brenner sees the good and the bad sides of radiation for health care, and his goal is to optimize radiation for situations where the benefits can be large and the risks small.

Radiation is very much a two-edged sword -- used in the right way it has revolutionized modern medicine -- such as through CT scans and as a cure for many cancers. But radiation used in the wrong way can be harmful. To maximize the benefits of the many different types of radiation, we need to understand exactly how they affect us -- from our DNA to the whole person.

Brenner directs the Center for Radiological Research at Columbia University Medical Center. He started his career in theoretical physics -- applying quantum mechanics to radiation therapy. While he has no doubt forgotten everything he knew about quantum mechanics, he has retained his love for applying hard-core physics concepts to solve biological problems. David has designed new "patient friendly" approaches for prostate cancer radiation therapy that are now in common use worldwide, and he is currently very excited about the prospects of beating pancreatic cancer with new types of radiation.

Over the past 6 years, Brenner has also been working towards a safe way to kill drug-resistant bacteria such as MRSA, as well as airborne viruses such as influenza, using a unique type of ultra-violet light.

columbia.edu/~djb3 @CRR_CUMC

Levon Biss

Photographer

With his "Microsculpture" series, Levon Biss photographs the incredible details of insects.

Levon Biss is a British photographer who works across many genres, including reportage, sport and portraiture. His passion for nature and photography have come together to create *Microsculpture*. For the project, a unique photographic process composites thousands of images using multiple lighting setups to create the final insect portraits. Each specimen was mounted on an adapted microscope stage, allowing close control over the position of the specimen in front of the camera lens. Most insects were photographed in about 30 sections, each section lit differently with strobe lights to accentuate the microsculpture of that particular area of the body. Each insect portrait is created from more than 8,000 separate images. In between his insect projects, Biss continues to photograph humans.

levonbiss.com @LevonBissPhoto

Mehdi Ordikhani-Seyedlar

Neuroscientist

Mehdi Ordikhani-Seyedlar is a postdoc at Duke, researching brain signals and their usage in brain-machine interfaces.

Mehdi Ordikhani-Seyedlar began his research on the neuropharmacology of learning and memory when he was studying veterinary medicine in Tabriz, Iran. Subsequently studying in France and Germany, he researched human visual attention, then started his PhD thesis focusing on decoding electrophysiological features of covert and overt attention in humans. He spent 2014 as a visiting scholar at the Nicolelis Lab at Duke University.

With his 2016 PhD from the Technical University of Denmark in hand, Ordikhani-Seyedlar took a postdoctoral position at Duke to develop algorithms to process large-scale neuronal activity and brain-machine interfaces. He hopes to begin May 1.

@mehdi_ordikhani

Richard Browning

Founder, Gravity

Richard Browning is the founder of human propulsion technology startup Gravity, which has invented, built and patented an Iron Man–like personal flight system.

Richard Browning is an ultra-marathon runner, an ex-Royal Marine reservist, former City commodity trader and a pioneering inventor. He's the founder of Gravity, launched in March 2017 with a dream to reimagine an entirely new form of human flight, leaning on an elegant collaboration of mind and body augmented by leading-edge technology.

Gravity has to date been experienced by over a billion people globally with video views alone running at more than 60m within seven days of launch. Browning's vision is to build Gravity into a world-class aeronautical engineering business, challenge perceived boundaries in human aviation, and inspire a generation to dare ask 'what if…'

gravity.co

Elizabeth Blackburn

Molecular biologist

Elizabeth Blackburn won a Nobel Prize for her pioneering work on telomeres and telomerase, which may play central roles in how we age.

Dr. Blackburn is the president of the Salk Institute and a pioneering molecular biologist. She received the Nobel Prize in Physiology or Medicine in 2009 for discovering the molecular nature of telomeres, the ends of chromosomes that serve as protective caps essential for preserving genetic information, and for co-discovering telomerase, an enzyme that maintains telomere ends. Both telomeres and telomerase are thought to play central roles in aging and diseases such as cancer, and her work helped launch entire new fields of research in these areas.

In addition to the Nobel Prize, Blackburn has received nearly every major scientific award including the Lasker, Gruber, and Gairdner prizes. She has served as president of the American Association of Cancer Research and the American Society for Cell Biology, and on editorial boards of scientific journals including *Cell* and *Science*. She coauthored the best-selling book *The Telomere Effect: A Revolutionary Approach to Living Younger, Healthier, Longer.*

salk.edu

HOUSE_OVERSIGHT_014966

Thursday, April 27, 2:15PM - 4:00PM PDT

Session 9: It's Personal

Hosted by Kelly Stoetzel and Helen Walters.

Helen Pearson

Science journalist, editor, author

Helen Pearson's book, "The Life Project," tells the extraordinary story of the longest-running study of human development in the world.

In March 1946, scientists began tracking almost every British baby born in a single week. What they discovered would change how we are born, grow up, raise children, live and die. Helen Pearson's 2016 book, *The Life Project,* is the story of this incredible project and the remarkable discoveries that have come from it. It was named best science book of the year by *The Observer* and was a book of the year for *The Economist*.

As Chief Magazine Editor for the world's leading science journal, *Nature,* Pearson oversees all its journalism and opinion content. Her own stories have won accolades including the 2010 Wistar Institute Science Journalism Award and two best feature awards from the Association of British Science Writers.

nature.com @hcpearson

Susan Pinker

Psychologist, columnist, author

Susan Pinker reveals how in-person social interactions are not only necessary for human happiness but also could be a key to health and longevity.

In her award-winning book *The Sexual Paradox*, Susan Pinker argued that biological differences could play an unexpectedly large role in creating the workplace gender gap. With *The Village Effect*, she tracks another current: how social, face-to-face interactions are critical for the survival of our species, and how technology is isolating us from these life-saving bonds. As she writes: "Neglecting to keep in close contact with people who are important to you is at least as dangerous to your health as a pack-a-day cigarette habit, hypertension or obesity."

In addition to her books, Pinker writes Mind and Matter, a column for the *Wall Street Journal* illuminating surprising advances in human behavior research. Pinker's numerous writings (including her weekly columns "Problem Solving" and "The Business Brain") have appeared in the *Guardian*, the *New York Times* and *Financial Times*, among many others.

susanpinker.com

Adam Alter

Psychologist

What makes us incessantly check our phones? Adam Alter dives into the fascinating psychology that drives our tech addictions.

Adam Alter's academic research focuses on judgment, decision-making and social psychology, with a particular interest in the sometimes surprising effects of subtle cues in the environment on human cognition and behavior.

He is the bestselling author of two books: *Irresistible*, which considers why so many people today are addicted to so many behaviors, from incessant smart phone and internet use to video game playing and online shopping, and *Drunk Tank Pink*, which investigates how hidden forces in the world around us shape our thoughts, feelings and behaviors.

adamalterauthor.com @adamleealter

Jeffrey Schnapp

Cultural historian

As the founder of metaLAB at Harvard, Jeffrey Schnapp thinks deeply on modern media, design, humanities and movement.

Jeffrey Schnapp is the founder/faculty director of metaLAB (at) Harvard and faculty co-director of the Berkman Klein Center for Internet and Society. Trained as a medievalist, his recent books and work concern the deeply modern, including *The Library Beyond the Book*, co-authored with Matthew Battles, on scenarios for libraries in the digital age, and *FuturPiaggio: Six Italian Lessons on Mobility and Modern Life*.

His pioneering work in media, design, digital arts and humanities as well as his curatorial practice includes collaborations with the Triennale di Milano, the Cantor Center for the Visual Arts, the Wolfsonian-FIU and the Canadian Center for Architecture. He is CEO and co-founder of Piaggio Fast Forward, developing imaginative solutions to the light mobility and transportation challenges.

jeffreyschnapp.com @jaytiesse

Chuck Nice

HOUSE_OVERSIGHT_014967

Comedian, science fan

The co-host of Star Talk Radio, Chuck Nice is a radio and TV veteran with a passion for science communication and comedy.

Chuck Nice is an 18-year veteran of stand-up comedy with a rich history in television and radio. Currently, he co-hosts *StarTalk* with Dr. Neil deGrasse Tyson on Nat Geo, and is the host of *Playing with Science*, a podcast he created under the StarTalk Radio umbrella. In addition, Chuck is the writer and producer of *Like A Damn Adult* for Newsy. He has also hosted his own shows, *Buy It Like a Mega Millionaire* and *Home Strange Home*, on HGTV, and co-hosted ABC's *The View*. His other familiar works include TRU TV's *World's Dumbest*, VH-1's *Best Week Ever*, and *Guys Tell All* on NBC's *Today*. Most weekends, he can be found on stage at one of New York's comedy clubs.

chucknicecomic.com @chucknicecomic

Guy Winch

Psychologist, author

Guy Winch asks us to take our emotional health as seriously as we take our physical health -- and explores how to heal from common heartaches.

Guy Winch is a licensed psychologist who works with individuals, couples and families. As an advocate for psychological health, he has spent the last two decades adapting the findings of scientific studies into tools his patients, readers and audience members can use to enhance and maintain their mental health. As an identical twin with a keen eye for any signs of favoritism, he believes we need to practice emotional hygiene with the same diligence with which we practice personal and dental hygiene.

His recent book, *Emotional First Aid: Healing Rejection, Guilt, Failure, and Other Everyday Hurts*, has been translated in 21 languages. He writes the popular "Squeaky Wheel Blog" on PsychologyToday.com, and he is the author of *The Squeaky Wheel: Complaining the Right Way to Get Results, Improve Your Relationships and Enhance Self-Esteem*. His new book, *How to Fix a Broken Heart*, will be published by TED Books/Simon & Schuster in 2017. He has also dabbled in stand-up comedy.

guywinch.com

Anne Lamott

Novelist, essayist

With disarming familiarity, Anne Lamott tackles what most don't like to consider. Her honest writing helps us make sense of life's chaos.

Anne Lamott hooks into our common experience and guides us to an understanding infused with openness. A Christian, an activist and a former alcoholic, Lamott uses humor to weave through loss, parenthood, faith and the cancer diagnosis given to her best friend, in beloved books like *Bird by Bird* and *Help, Thanks, Wow: The Three Essential Prayers* . She says, "Hope begins in the dark ... if you just show up and try to do the right thing, the dawn will come. You wait and watch and work: you don't give up."

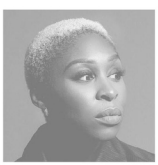
Her next book, *Hallelujah Anyway; Rediscovering Mercy*, is set to release in April 2017.

@annelamott facebook.com/AnneLamott

Thursday, April 27, 5:00PM - 7:00PM PDT

Session 10: Tales of Tomorrow

Hosted by Chris Anderson and Juliet Blake.



Cynthia Erivo

Actor, performer

Best known for her role in the Broadway revival of "The Color Purple," Cynthia Erivo is a Tony- and Grammy-winning performer.

Cynthia Erivo made her Broadway debut as Celie in *The Color Purple* — a role that earned her Tony and Grammy Awards. Erivo has performed for the annual Kennedy Center Honors and been featured on stage in *Sister Act* as well as *A Midsummer Night's Dream*. Most recently, Erivo teamed up with John Legend at the 2017 Grammy Awards to perform the Beach Boys' song, "God Only Knows."

The actress stars with Viola Davis in the upcoming Steve McQueen film *Widows*, and as Harriet Tubman in the biopic *Harriet*.

facebook.com/cynthiaerivo @CynthiaEriVo

Manoush Zomorodi

Tech podcaster

Every week on her podcast "Note to Self," Manoush Zomorodi searches for answers to life's digital quandaries.

Manoush Zomorodi is the host and managing editor of *Note to Self*, "the tech show about being human," from WNYC Studios. Through experiments and conversations with listeners and experts, she examines the new questions tech has brought into our lives. Topics include information overload, digital clutter, sexting "scandals" and the eavesdropping capabilities of our gadgets.

HOUSE_OVERSIGHT_014968

In January 2017, Manoush and Note to Self launched "The Privacy Paradox," a 5-part plan to help people take back control over their digital identity. Tens of thousands of listeners have completed the 5-part plan so far, which *Fast Company* calls Manoush's "challenge to us to stick up for our internet rights." Her book exploring how boredom can ignite original thinking, *Bored and Brilliant: Rediscovering the Lost Art of Spacing Out*, comes out in September 2017.

wnyc.org/shows/notetoself @manoushz

Shah Rukh Khan

Actor, producer, activist

With a fan following that runs into multi-millions, and 24 million followers on Twitter, Shah Rukh Khan is at forefront of the Indian film industry and continues to rule at the box office in India.

One of the world's biggest movie stars, Bollywood star Shah Rukh Khan is also an entrepreneur and inspired philanthropist. He heads the film production company Red Chillies Entertainments, whose *Chennai Express* was the highest-grossing film of 2013, and his recent film *Raees* also topped the box office in India. He's also the proud co-owner of two cricket franchises, the Kolkata Knight Riders and the Trinbago Knight Riders.

In the fall, he will host TED's brand-new TV series in Hindi for Star Plus, titled *TED Talks India: Nayi Soch,* which translates to "new thinking."

As a philanthropist and spokesperson, Khan stands up for causes ranging from the environment and water-supply issues to rural solar power. Khan's nonprofit Meer Foundation, named for his father, focuses on supporting victims of acid attacks through a 360-degree approach that helps with medical treatment, legal aid, rehabilitation and livelihood support.

@iamsrk

Paul Cantelon

Musician and composer

Paul Cantelon is a composer of contemporary classical music and resonant, award-winning film scores -- as well as a violinist, pianist and accordionist.

From his debut at the age of 13, at UCLA's Royce Hall, Paul Cantelon commenced a successful career as a concert pianist, until some years later he was abruptly stopped by a life-altering bicycle accident whilst at the Paris Conservatory.

Out of this crisis, Cantelon reinvented his musical career, which would come to encompass such extremes from playing with the Red Hot Chili Peppers, to his eventual status as a Bafta-nominated film composer known for such scores as Julian Schnabel's *The Diving Bell and the Butterfly'* and Oliver Stone's *W.*

paulcantelon.com

Ashton Applewhite

Author, activist

Ashton Applewhite asks us to look at ageism -- the assumption that older people are alike and that aging impoverishes us. (Is that your experience?)

Ashton Applewhite would like us to think differently about growing older. As she writes: "Aging is a natural, lifelong, powerful process that unites us all. So how come so many of us unthinkingly assume that depression, diapers, and dementia lie ahead? Because of ageism—the last socially sanctioned prejudice."

She's the author of *This Chair Rocks: A Manifesto Against Ageism* and is the voice of the Yo, Is This Ageist? blog. She is also the author of *Cutting Loose: Why Women Who End Their Marriages Do So Well* -- and was a clue on *Jeopardy!* as the author of the mega bestseller series, *Truly Tasteless Jokes*. (Who is Blanche Knott?)

thischairrocks.com @thischairrocks

Laolu Senbanjo

Artist, musician, lawyer, activist

Laolu Senbanjo's motto is: "Everything is my canvas."

A visual artist, musician, human rights lawyer and activist, Laolu Senbanjo puts his mark on everything from canvas, to shoes, to walls and buildings, to clothing and even the body with his Sacred Art of the Ori. Born and raised in Ilorin, Nigeria, his Yoruba heritage is ever-present in his work, which marries modern detail and ornate style to create a vision of Afrofuturism.

His preferred medium is charcoal, "because it's something as natural as life and death," he writes, and he also works in acrylics, inks and even wood. Senbanjo created work for the astonishing "Sorry" video from Beyoncé's *Lemonade,* and he has worked with Angelique Kidjo, Kenneth Cole, Alicia Keys, Usher and many more.

laolu.nyc @afromysterics

Helen Zaltzman

Podcaster

Helen Zaltzman makes The Allusionist, a podcast about "small adventures in language."

HOUSE_OVERSIGHT_014969

In 2007, Helen Zaltzman sat down with collaborator Olly Mann in a suburban London living room and launched Answer Me This! (AMT), an infectiously funny podcast based on listener questions. AMT became a sensation and vaulted her to early celebrity in the comedy podcast pantheon -- it went on to garner a bouquet of awards, land a BBC5 radio show, and spawn a companion book.

Zaltzman podcast, *The Allusionist*, is a humorous look at linguistics, part of the podcast network Radiotopia.

theallusionist.org @helenzaltzman

David Whyte

Poet, author

David Whyte writes at the intersection of interior and exterior worlds, bringing new territory into view with his distinctly personal style.

A native of Yorkshire, England, David Whyte draws from his diverse background and a deep philosophical curiosity to craft poems that are at once highly relatable, yet altogether new. Whyte explores the human experience, writing about relationships in his poetry as well as his prose. His work spans the worlds of literature, philosophy and organizational leadership, making him a wise voice to listen to in an increasingly complex world.

His books include *The Sea in You: Twenty Poems of Requited and Unrequited Love*; *The Three Marriages: Reimagining Work, Self and Relationship*; *River Flow: New & Selected Poems*; and *Consolations: The Solace, Nourishment and Underlying Meaning of Everyday Words*.

davidwhyte.com @whytedw

Friday, April 28, 9:30AM - 12:00PM PDT

Session 11: The Future Us

Hosted by Chris Anderson, Kelly Stoetzel and Helen Walters.

Jim Yong Kim

President of the World Bank Group

Jim Yong Kim is leading the World Bank Group in the global effort to end extreme poverty and promote shared prosperity.

Jim Yong Kim is the 12th president of the World Bank Group. Soon after he assumed his position in July 2012, the organization established two goals to guide its work: to end extreme poverty by 2030; and to boost shared prosperity, focusing on the bottom 40 percent of the population in developing countries. In September 2016, the World Bank Group Board unanimously reappointed Kim to a second five-year term as president.

During his first term, the World Bank Group supported the development priorities of countries at levels never seen outside a financial crisis and, with its partners, achieved two successive, record replenishments of the World Bank Group's fund for the poorest. The institution also launched several innovative financial instruments, including facilities to address infrastructure needs, prevent pandemics and help the millions of people forcibly displaced from their homes by climate shocks, conflict, and violence.

Kim's career has revolved around health, education and delivering services to the poor. In 1987, Kim co-founded Partners In Health, a nonprofit medical organization that works in poor communities on four continents. He has received a MacArthur "genius" grant, was recognized as one of America's "25 Best Leaders" by U.S. News & World Report and was named one of TIME magazine's "100 Most Influential People in the World."

worldbank.org @JimYongKim

Emily Esfahani Smith

Author

In her book "The Power of Meaning," Emily Esfahani Smith rounds up the latest research -- and the words of great thinkers across generations—to argue that the search for meaning is far more fulfilling than the pursuit of personal happiness.

Emily Esfahani Smith is the author of *The Power of Meaning: Crafting a Life That Matters*, a book that explores how we can each find meaning in life. She says: "In recent decades, there's been a rising tide of despair across the world—people feeling more depressed and alone, and even ending their lives. To be psychologically and spiritually healthy, we need to believe that our lives are meaningful. We all need to discover ways to feel connected to something larger than ourselves -- to feel that our lives make sense. Fortunately, we can all do this -- we can all create meaningful lives."

Smith draws on psychology, philosophy and literature to write about the human experience -- why we are the way we are and how we can find grace and meaning in a world that is full of suffering. Her articles "There's More to Life than Being Happy" and "Masters of Love," originally published in *The Atlantic*, have been read more than 30 million times. Her writing has also appeared in the *Wall Street Journal*, *New York Times* and *TIME*. She is an instructor in positive psychology at the University of Pennsylvania. She is also a columnist for *The New Criterion*, as well as an editor at the Stanford University's Hoover Institution, where she manages the Ben Franklin Circles project, a collaboration with the 92nd Street Y and Citizen University to build meaning in local communities.

emilyesfahanismith.com @EmEsfahaniSmith

Found Sound Nation

HOUSE_OVERSIGHT_014970

Musical collective

Found Sound Nation (FSN) is a collective of artists who use music-making to connect people across cultural divides.

FSN believes that collaborative music creation is a deeply effective way to become aware of the beauty, trauma and hidden potential in our communities. Their process gives voice to the underrepresented, unlocks the creative potential of youth and supports movements for social justice.

Founded by Christopher Marianetti and Jeremy Thal in 2010, FSN began its work as part of the groundbreaking new music organization, Bang on a Can. Over the years, FSN has led audio production workshops for Cine Institute in Haiti, worked extensively with Carnegie Hall in New York, Indonesia and Mexico, and developed music composition workshops with incarcerated youth in theBronx and Brooklyn.

In the field of cultural diplomacy, FSN developed the Dosti Music Project with US Embassies in Pakistan and India to bring together politically divided artists to create and tour original work. Since 2012 FSN has partnered with the US Department of State's Bureau of Educational and Cultural Affairs and Bang on a Can to produce OneBeat, to convene young professional musicians from around the globe each fall to use music as a tool for the betterment of our communities, forming a growing web of interconnected musical change-makers from around the globe.

foundsoundnation.org @foundsoundnat

Elon Musk

Serial entrepreneur

Elon Musk is the CEO and product architect of Tesla Motors and the CEO/CTO of Space Exploration Technologies (SpaceX).

At SpaceX, Musk oversees the development of rockets and spacecraft for missions to Earth orbit and ultimately to other planets. In 2008, SpaceX's *Falcon 9* rocket and *Dragon* spacecraft won the NASA contract to provide cargo transport to space. In 2012, SpaceX became the first commercial company to dock with the International Space Station and return cargo to Earth with the *Dragon*.

At Tesla, Musk has overseen product development and design from the beginning, including the all-electric Tesla Roadster, Model S and Model X, and the rollout of Supercharger stations to keep the cars juiced up. (Some of the charging stations use solar energy systems from SolarCity, of which Musk is the non-executive chair.) Transitioning to a sustainable energy economy, in which electric vehicles play a pivotal role, has been one of his central interests for almost two decades. He co-founded PayPal and served as the company's chair and CEO.

elonmusk.com @elonmusk

Noah Feldman

Constitutional law scholar

Noah Feldman studies the intersection of religion, politics and law.

Noah Feldman is a professor and writer who tries to figure out how to make the government follow the rules; what the rules are that the government has to follow; and what to do if the rules are being broken. In his work, he asks questions like: How can a 225-year-old constitutional blueprint still work? Can you design a new and better constitution from scratch in places like Iraq and Tunisia? What rights do we have, really?

Feldman is the Felix Frankfurter Professor of Law at Harvard Law School and a contributing writer for *Bloomberg View*. He served as senior constitutional advisor to the Coalition Provisional Authority in Iraq, and advised members of the Iraqi Governing Council on the drafting of the Transitional Administrative Law or interim constitution. He is writing a biography on James Madison, principal author of the Constitution and fourth president of the US; it's forthcoming in 2017.

Feldman is the author of six other books: Cool War: The Future of Global Competition (Random House, 2013); Scorpions: The Battles and Triumphs of FDR's Great Supreme Court Justices (Twelve Publishing, 2010); *The Fall and Rise of the Islamic State* (Princeton University Press, 2008); Divided By God: America's Church-State Problem and What We Should Do About It (Farrar, Straus & Giroux 2005); What We Owe Iraq: War and the Ethics of Nation building (Princeton University Press 2004) and After Jihad: America and the Struggle for Islamic Democracy (Farrar, Straus & Giroux 2003. He most recently co-authored two textbooks: Constitutional Law, Eighteenth Edition (Foundation Press, 2013) and First Amendment Law, Fifth Edition (Foundation Press, 2013).

Julia Sweeney

Actor, comedian, playwright

Julia Sweeney creates comedic works that tackle deep issues: cancer, family, faith.

Julia Sweeney is a writer, director, actress, comedian and monologist. She is known for being a cast member on *Saturday Night Live* from 1990 to 1995, where she created and popularized the androgynous character, Pat. She is also well known for her comedic and dramatic monologues. *God Said Ha!* is a monologue about serious illness, her brother's lymphoma and her own cancer, and her family's crazy reactions to this crisis as they soldiered their way through struggle, confusion and death. This play was performed all over the U.S. and on Broadway at the Lyceum Theater. It was made into a film produced by Quentin Tarantino, and the comedy album from the show was nominated for a Grammy.

Sweeney's second monologue, *In the Family Way,* played in theatrical runs in New York and Los Angeles. It was ultimately fashioned into a book, a memoir titled *If It's Not One Thing, It's Your Mother*. Sweeney's third monologue, *Letting Go of God*, chronicled her journey from Catholicism to atheism. It was made into a film that played on Showtime.

juliasweeney.com @JuliaSweeney

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MLI (UK)

Nitin Saksena
Equity-Linked Analyst
MLPF&S

William Chan, CFA >>
Equity-Linked Analyst
Merrill Lynch (Hong Kong)

Abhinandan Deb >>
Equity-Linked Analyst
MLI (UK)

Benjamin Bowler
Equity-Linked Analyst
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benjamin.bowler@baml.com

Jason Galazidis >>
Equity-Linked Analyst
MLI (UK)

Clovis Couasnon >>
Equity-Linked Analyst
MLI (UK)

Chintan Kotecha
Equity-Linked Analyst
MLPF&S

Michael Youngworth
Equity-Linked Analyst
MLPF&S

Nikolay Angeloff
Equity-Linked Analyst
MLPF&S

See Team Page for List of Analysts

US

Extract alpha from summer SPX range as policy and positioning "collar" equities

With the Federal Reserve last week appearing more emboldened to normalize monetary policy, risk asset bears have come out in force. While we agree that a changing Fed reaction function is likely not supportive of substantial equity upside, we think the "Yellen put" still exists, albeit with a lower strike. Hence, we see monetary policy as providing a near-term "collar" (long put/short call) on a US equity market already prone to getting trapped in record-tight trading ranges. Further impetus for a summer range-trade should come from (i) fiscal policy, as gridlock caps equity upside but policy hope floors the downside, and (ii) positioning, where the risk of continued "fragility events" (potentially exacerbated by stretched quant fund/short vol positioning) meets cashed-up investors still accustomed to buying dips. As a risk-limited range trade, we like buying in-the-money down and out puts on the S&P. For example, an SPX Sep 2475 put that knocks out at 2300 (6% OTM) indicatively costs 70bps (spot ref 2451), a 60% discount to the 2475 / 2300 put spread.

Europe

Long EU banks dispersion: Buy Dec17 call on a basket, sell worst-of call

We recommend positioning for greater dispersion in EU bank sector returns via buying a Dec17 105% call on an equally-weighted basket of Santander, BNP, ING, Intesa and Deutsche Bank, part-financed by selling a worst-of call on the same basket for 1.8% (net) indic., as: 1) improving macro/earnings, sensitivity to rates and regulatory headwinds are likely to lead to greater differentiation within banks, 2) the entry point is attractive given historically low implied vol (13th 8y+ percentile) and high implied correlation (81% bid vs latest 6M realised correl of 66%), 3) historical risk-reward at current pricing is attractive (avg. P&L of +8.4% when positive vs -1.8% when negative), and 4) the trade can be considered as a cheap call on EU equities as it has a similar payoff profile but with greater benefit relative to its cost.

Asia

Buy depressed China vs. US risks through corridor variance spreads

As global central banks have taken on more hawkish tones, the uncertainty surrounding policy tightening will be more positive for EM volatility than for DM volatility. Additionally, our strategists have a more bearish outlook for the Chinese banking sector (which makes up a majority of the HSCEI index) amid rapidly rising leverage, complex shadow banking, and excessive home price inflation. Since we believe the global synchronized monetary tightening will impact HSCEI volatility more than SPX volatility, we recommend owning HSCEI-SPX 70/110% corridor variance at 5 vol points, a 3 vol point discount to a vanilla variance spread. The entry point is attractive as the HSCEI-SPX 18-month variance swap spread has fallen back to the lower-end of its 5-year trading range, the trade has a positive carry, and it benefits during China risk-off events.

Table 1: 3M volatility (weekly changes)

	Implied	Realized
S&P500	9.8 (-0.2)	7.1 (-0.2)
ESTX50	13.4 (0.3)	11.5 (0.2)
FTSE	10.0 (-0.4)	9.7 (0.2)
DAX	12.6 (0.3)	10.7 (0.5)
NKY	13.8 (-0.2)	12.3 (-0.2)
HSI	12.4 (0.1)	10.1 (0.2)
KOSPI	12.2 (0.3)	10.5 (0.1)
EEM US	15.6 (0.5)	11.8 (-1.1)
TOP40	16.9 (1.2)	11.1 (0.3)
RDX	25.9 (0.9)	20.6 (-1.1)
IBOV	22.9 (-1.7)	25.5 (-0.7)
ISE30	20.2 (0.4)	13.5 (0.1)

Source: BofA Merrill Lynch Global Research

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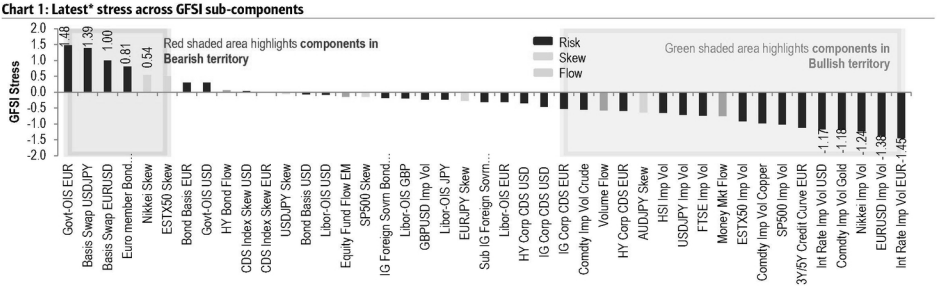
BofAML GFSI™ X-Asset Risk Landscape

Stress now below normal for all asset classes

The indicator was little changed last week, finishing at -0.23.

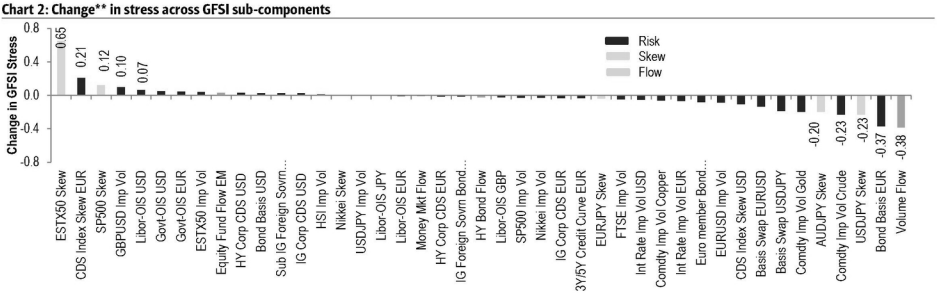
- **Stress is now in benign territory across all five asset classes**: Stress in across all asset classes (except equity) declined last week. Notably, rates stress turned negative (benign territory) and stresses across all five asset classes are now negative.
- **Stress in Equity skew rose** as ESTX50 and (to a lesser extent) S&P500 skew steepened; indeed the gain in ESTX50 skew was the greatest across GFSI sub-components (Chart 2) and also historically significant (Chart 5).
- **Commodity-related stresses fell** the most across asset classes (Chart 3), led by declines in Crude and Gold vol (Chart 2), reversing some of the gains after geopolitical tensions in the Middle East rose in recent weeks.

Chart 1: Latest* stress across GFSI sub-components



Source: BofA Merrill Lynch Global Research. *Latest as of 16-Jun-17.

Chart 2: Change in stress across GFSI sub-components**



Source: BofA Merrill Lynch Global Research. **Latest as of 16-Jun-17. Change vs 1 week prior (9-Jun-17).

The GFSI Risk Allocator (using Bull, Bear & Neutral weights of 2, 0, 1) suggested a 17.4% overweight position on 16-Jun (vs 13.0% OW as of 9-Jun). The percentages of Bullish, Bearish and Neutral GFSI components (as used in the Risk Allocator) as of 16-Jun were 34.8%, 17.4% and 47.8% respectively.

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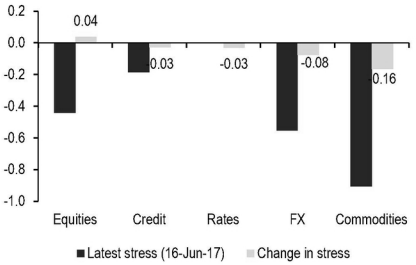
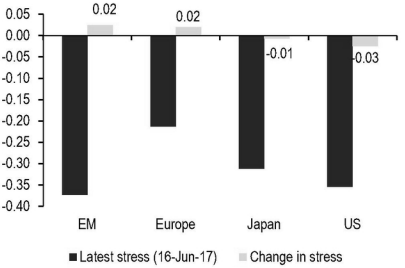
Chart 3: Stress in commodities fell the most last week (driven by a drop in crude oil vol) while stress in equities rose marginally (led by equity skew)



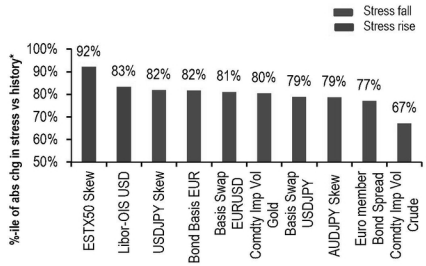
Source: BofA Merrill Lynch Global Research. 1wk change (9-Jun-17 to 16-Jun-17).

Chart 4: EM and the US are the least stressed GFSI regions globally



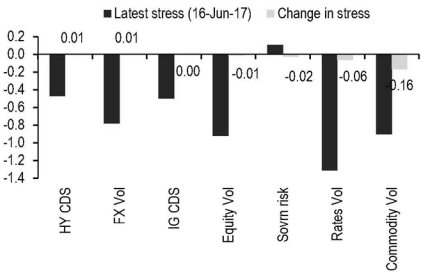
Source: BofA Merrill Lynch Global Research. 1wk change (9-Jun-17 to 16-Jun-17).

Chart 5: Top 10 movers in stress (1-week abs chg %-ile vs history*)



Source: BofA Merrill Lynch Global Research. * %-ile of weekly move in stress vs all historical weekly moves (earliest 3-Jan-00). Bar colours represent: rise (red) or fall (green) in stress. 1wk change (9-Jun-17 to 16-Jun-17).

Chart 6: Global volatility & credit spread stress in the GFSI



Source: BofA Merrill Lynch Global Research. 1wk change (9-Jun-17 to 16-Jun-17).

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Volatility in the US

Risk-limited alpha in a "collared" market: SPX ITM KO puts

US equities vulnerable...to a summer range-trade

The Federal Reserve last week appeared more emboldened to normalize monetary policy, not only raising interest rates by 25bps but also reiterating its intention to hike four more times by the end of 2018 and stating that it "expects to begin implementing a balance sheet normalization program this year" - all despite recent softness in inflation data. Breakeven rates of inflation narrowed following the Fed communications due to tighter monetary conditions in the face of slowing US economic data, and risk asset bears responded in force, suggesting that Janet Yellen had "broken up" with investors and that it would be prudent to sell "before it's too late".

We agree that the changing reaction function of the Fed is likely not supportive of further substantial US equity upside and may be viewed as the Fed now providing a short call option on the S&P 500. However, in our view, it is premature to conclude from last week's developments that the "Yellen put" is dead. We see its strike as declining but would not underestimate Yellen's dovish inclinations in a shock or the capacity for the Fed to still remain credibly on hold as long as the US economy is not "running hot".

In short, we see monetary policy as now providing a "collar" (long put / short call) on a US equity market that has already shown a propensity over the past year for getting trapped in record tight trading ranges.[1] Other factors may also conspire to create a summer range-trade for US equities, namely (i) fiscal policy, where gridlock likely caps equity upside but lingering policy hope floors the downside, and (ii) positioning, where the risk of continued "fragility events" (potentially exacerbated by stretched quant fund/short vol positioning) meets cashed-up investors still accustomed to buying dips.

Tug of war between fragile market/stretched positioning and cashed-up dip-buyers

As we have noted recently, US equities have displayed a historically unusual tendency to jump rapidly from calm to stress and back ("fragility"), with the recent Tech sell-off and rebound the latest example. For example, in the past year, the S&P 500 has seen 5sigma declines (3 in total—Brexit, Sep-16, May-17) occur 20x more frequently than over the prior 90 years or so. The increased frequency of these "fragility events" is in part due to vol failing to remain high post a spike as equity market participants continue to aggressively "buy the dip" and in the process reset vol lower.

Historically low vol alongside consistently upward trending equity markets and low cross asset correlations could be creating stretched positioning across markets. For example, upward trending equities on historically low vol may be pushing CTA equity positioning to near record levels (Chart 7). Risk parity portfolios could be increasing their leverage due to low vol as well as low cross asset correlation (Chart 8). And lastly, inverse VIX ETPs have seen increased open interest as performance has swelled on the back of continued declines in vol and attractive term structure risk premia (Chart 9).

Should vol spike again alongside a reversal in equity price momentum and a rise in cross asset correlations, then unwinds from these strategies could exacerbate market fragility. However, this must be weighed against an investor base that has plenty of cash on hand (Chart 10) and their potentially fickle but still-intact tendency to view any equity market dip as an alpha opportunity.

[1] For example, the Dow Jones Industrial Average traded in its tightest trading range in over 110 years in Jan-17; this followed a record in the S&P 500 ending Sep-16 for the longest stretch of trading within a range of 1.77% since 1928.

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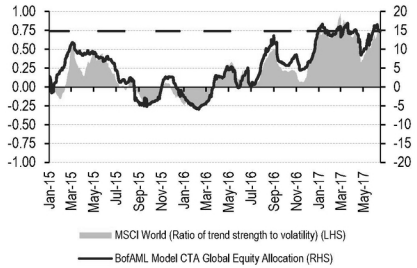
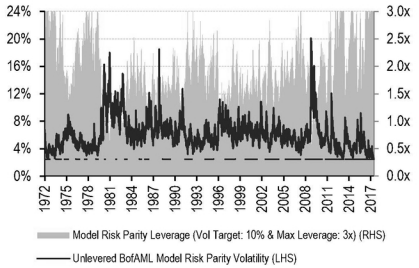
Chart 7: A combination of upward trending global equity markets and very low volatility have conspired to push trend following (CTA) equity positioning to near record levels. Consequently, the beta of CTA strategies to global equities is also at extreme levels



Source: BofA Merrill Lynch Global Research. Based on daily data form 2-Jan-2015 to 16-Jun-2017. CTA = Commodity Trading Advisor

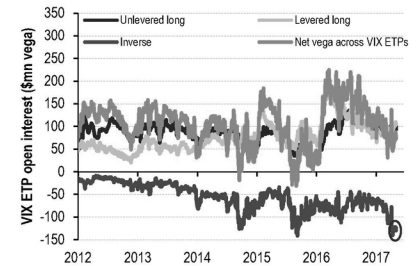
Chart 8: Owing to low cross asset vol and strong diversification, the volatility of risk-balanced multi-asset portfolios has fallen to historically low levels. Consequently, leverage levels across multi-asset & other portfolios that target fixed vol have likely hit their caps



Source: BofA Merrill Lynch Global Research. Based on daily data from 3-Jan-72 through 16-Jun-17. Equity, fixed income, and commodity components within the hypothetical risk parity investment are represented by the S&P500, 10-Year US Treasury Bonds, and the S&P GSCI Index, respectively. Risk parity allocations are determined and rebalanced monthly using prior 12-month realized volatility and correlations.

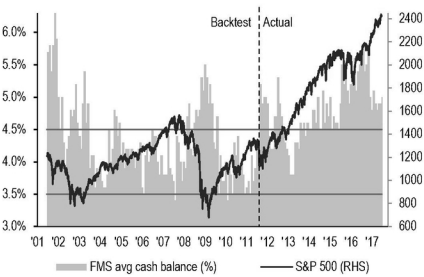
It is important to note that not all CTA, risk parity, or vol control strategies operate similarly and there is model risk in estimating the exact size of these trading flows.

Chart 9: The vega outstanding in inverse VIX ETNs has also reached a record high at ~$125mn vega



Source: BofA Merrill Lynch Global Research. Daily data from 13-Feb-12 through 16-Jun17.

Chart 10: Global FMS average cash balances (%) remain elevated, suggesting dry powder for investors still conditioned to buy equity dips



Source: BofA Merrill Lynch Global Fund Manager Survey, Bloomberg. As a reminder, the FMS Cash Rule works as follows: when average cash balance rises above 4.5% a contrarian buy signal is generated for equities. When the cash balance falls below 3.5% a contrarian sell signal is generated.

Extract risk-limited alpha from SPX range via cheap in-the-money knockout puts

As a risk-limited range trade, we like owning down-and-out puts on SPX that are already in-the-money. For example, the SPX Sep 2475 put with a 2300 knock-out (continuous observation) indicatively costs 70bps (spot ref 2451) and offers a 60% discount to the vanilla 2475/2300 put spread, which is itself historically cheap (Chart 12).

If SPX stays above the 2300 barrier at all points in time before expiry, the structure is equivalent to a 2475 put option. If the barrier is instead breached, the maximum loss will be equal to the (low) upfront premium. The 2300 barrier is about 6% out-of-the-money, hence "allows" for the elusive 5% correction not seen since Brexit (on a closing basis). However, investors can mitigate the risk of breaching the barrier by either moving it farther down (e.g., a 2245 barrier would indicatively raise the cost from 0.7% to 1%), or by only observing it on a close-to-close basis (in turn sacrificing part of the discount).

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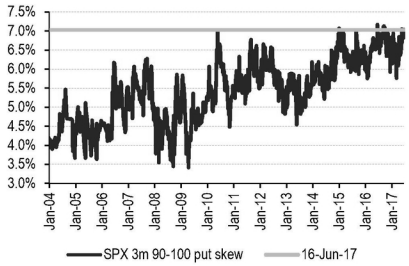
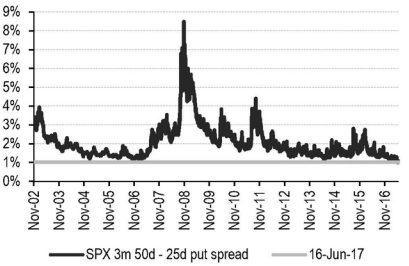
The trade prices attractively today due to exceptionally steep SPX put skew, which is near its highs established since 2004 (Chart 11). With steep SPX put skew, the market is implicitly pricing in a high probability that the option will knock-out during its life, i.e., that relatively large drawdowns are more likely. As detailed above, however, we see many reasons why the most likely near-term scenario for US equities is to remain range-bound. The structure is short 11% delta at inception and has the same vega sensitivity as the equivalent put spread (short 6bps).

Chart 11: SPX put skew is near the all-time highs reached since 2002. Steep skew helps cheapen knockout puts as the market is implying a relatively high probability of the barrier being breached



Source: BofA Merrill Lynch Global Research. Data from Jan-04 to 16-Jun-17. The 90 and 100 strikes are based on the SPX forward.

Chart 12: The price of SPX put spreads is already near the lows reached since 2002. In particular, the price of a 3m 50d-25d put spread is ~1.02%, in the 0.1st %-ile since Nov-02



Source: BofA Merrill Lynch Global Research. Data from Nov-02 to 16-Jun-17.

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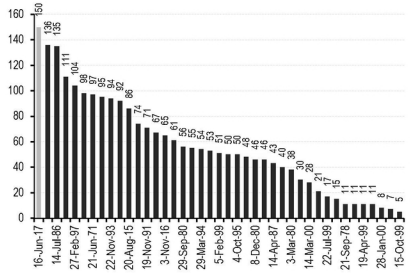
Notable trends and dislocations (US)

The Fed turns more hawkish, though vol remains subdued

Last week, unsurprisingly the Fed opted to hike benchmark rates another 25bps. However, the market was more focused on the FOMC's unexpectedly hawkish message, which indicated that it is willing to normalize policy despite weaker-than-desired inflation. Our economists now think the Fed will announce balance sheet normalization in September and will hike rates again in December. A more hawkish Fed could result in higher real rates and a stronger USD, which ultimately should benefit our Growth to Value rotation trade of long XLF calls versus short QQQ calls (see Chart 15). The S&P 500 was more-or-less flat week-over-week as it gained only 6bps. The tech selloff continued, however, and the Nasdaq-100 dropped 105bps. Similarly, the Russell 2000 also dropped 105bps. Despite concerns on the Fed, the VIX fell 0.32 vol points to 10.38, and SPX 1m ATM implied vol declined 0.3 vol points to 7.6%.

Chart 13: The Nasdaq has set a new record for consecutive days without a 5% peak-to-trough drawdown

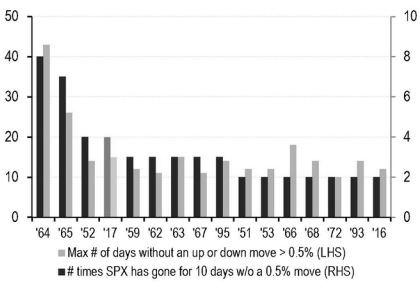


Source: BofA Merrill Lynch Global Research. Data from 1-Feb-71 to 16-Jun-17. Drawdowns measured from prior peaks and using close-to-close data.

On June 9, the Nasdaq dropped nearly 2% as investors unwound crowded positions, resulting in a sudden selloff from a period of relative calm. However, despite the volatility among tech names during the first week of June, the Nasdaq (CCMP) has not seen a 5% drawdown from a prior peak (using closing data) in 150 days. This is the longest such streak in the Nasdaq's history.

Prior to today, the longest periods of similar calm occurred during July '83 and July '86, when the index did not record a 5% drawdown from a peak in 136 and 135 days respectively.

Chart 14: On 16-Jun, the SPX had its 11th consecutive session of moves not exceeding 0.5% in either direction on a close-to-close basis. This is the 4th time this year that such a streak has surpassed 10 days



Source: BofA Merrill Lynch Global Research, Bloomberg. Data from Jan-1928 to 16-Jun-2017.

Last week the S&P 500 recorded its 11th session without a move larger than 0.5% in either direction. As a result, 10d realized vol stood at 3.31% as of 16-Jun.

This is already the fourth time this year that SPX has gone more than 10 consecutive days without a move greater than +/- 0.5%. This has historically happened only in '64, '65 and '52. The longest such stretch this year lasted 15 consecutive trading sessions and ended on 16-May. For comparison, in '64 SPX had 8 stretches without such a move with the longest stretch spanning 43 days.

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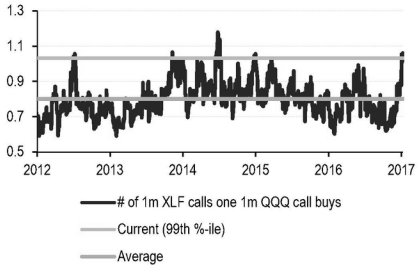
Chart 15: Buying an XLF 1m ATM call financed by selling a QQQ 1m call is still an attractive way for investors to rotate out of Growth and into Value



Source: BofA Merrill Lynch Global Research. Data from 9-Jun-12 to 16-Jun-17.

Last week, we highlighted that investors who want to rotate out of Growth strategies into Value strategies should take advantage of elevated tech vol by buying XLF 1m ATM calls financed by selling QQQ 1m ATM calls. After last week's FOMC meeting, the case for such a trade grows even stronger as the market thinks the Fed has become more hawkish, driving up real rates and the USD. Amid this backdrop, one could see outperformance of Value names over Growth names, which tend to have higher amounts of offshore revenues that would come under pressure by a stronger dollar.

Additionally, the trade remains attractive at current levels as pricing has only been better 1% of the time in 5 years. Today, 1.03 XLF calls could be bought for each QQQ call sold, whereas over the past 5 years, the average number of XLF calls that could be purchased was only 0.80.

Table 2: Current S&P500 volatility and correlation measures relative to the prior two year of historical daily data

	1-week change			Over 2-year historical period					
	16 Jun 17	9 Jun 17	Change	Current ranking	Minimum	25%	Median	75%	Maximum
1-month ATM implied volatility	7.6%	7.9%	-0.3%	1.3%	7.1%	9.8%	11.7%	14.5%	31.8%
1-year ATM implied volatility	14.0%	14.0%	0.0%	7.7%	13.4%	15.3%	16.2%	17.3%	22.5%
1-week intraday realized volatility	7.8%	7.3%	0.5%	19.6%	5.2%	8.3%	10.6%	14.0%	53.7%
1-year minus 1-month term structure	6.5%	6.1%	0.4%	99.2%	-12.0%	2.7%	4.4%	5.4%	7.0%
3-month 90 minus 110 skew	8.5%	8.3%	0.2%	16.1%	7.1%	9.4%	11.3%	11.8%	13.8%
1-year top 50 implied correlation	45.44	45.10	0.35	8.1%	42.03	49.37	54.22	57.14	65.55
3-month top 50 realized correlation	21.30	24.08	-2.78	16.8%	12.57	27.15	37.28	48.45	60.41
VIX 1-month ATMf implied vol	81.9%	80.0%	1.9%	39.9%	61.2%	78.2%	85.0%	95.2%	162.2%
VIX 1-month 110 minus 90 skew	27.1%	26.9%	0.2%	88.6%	9.3%	18.6%	21.5%	23.8%	30.3%

Source: BofA Merrill Lynch Global Research

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Volatility in Europe

Buy EU banks dispersion: (+) basket call, (-) worst-of calls

Trade: Long Dec17 105% call on an equally weighted basket of SAN, BNP, ING, ISP & DBK*, short Dec17 ATM worst-of call on the same basket for 1.8% indic. (correl bid: 81%).

** We pick the top 5 stocks with the largest market cap within the SX7E (EU banks sector index) corresponding to 5 different countries*

We have previously highlighted our preference for vol dispersion trades both in the US and the EU – with the most recent recommendation being sector dispersion opportunities within the EU. In a similar vein, we suggest positioning for greater dispersion within EU banks via buying a call on a basket of Santander, BNP Paribas, ING, Intesa and Deutsche Bank part-financed by selling a worst-of call on the same basket as:

- **Improving macro/earnings, sensitivity to rates and regulatory headwinds likely to lead to greater differentiation within banks**: An improving macro backdrop in Europe & ongoing improvement in EPS revisions (see Style Cycle) paint a bullish picture for EU banks as they are seen as leveraged macro plays within the EU. However, we believe there is a potential for greater differentiation within banks as our bank analysts have argued before (here and here) that: (i) some banks stand to benefit more than others based on their earnings power should the uptick in the earnings cycle continue, (ii) banks' gearing to interest rate cycles, and therefore likely impact from a more hawkish ECB, varies between different banks and (iii) French and Benelux banks are likely to be most impacted under potential Basel IV regulations.

- **Entry point is attractive given historically low implied vols:** The structure benefits from its long vol bias as average 6M implied vol on the basket of 5 European banks is historically low (13th %-ile since Jan-08, Chart 16).

- **High implied correlation beneficial for structure's short correlation bias**: Chart 17 shows the average pairwise 6M and 3M realised correlations between the 5 EU banks, which are historically low. Despite this recent drop in realised correlations, implied correlation is priced higher, thus providing an interesting entry point for the (short-correlation) trade.

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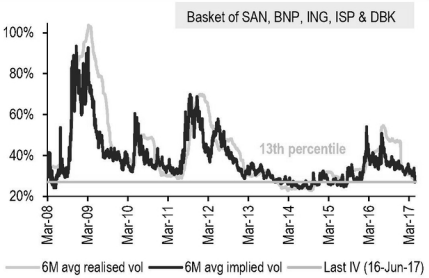
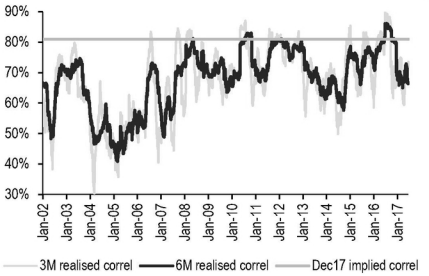
Chart 16: SAN, BNP, ING, ISP and DBK average 6M ATMf implied vol is trading historically low (13th percentile since 2008)



Source: BofA Merrill Lynch Global Research. Data: 2-Jan-08 to 16-Jun-17

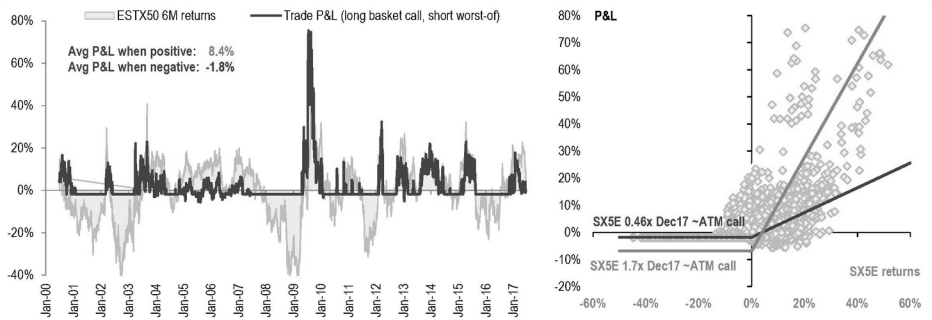
Chart 17: Despite the recent drop in realized correlation, implied correlation is priced near the high end of the reaiised range for the basket of EU banks



Source: BofA Merrill Lynch Global Research. Data: 2-Jan-08 to 16-Jun-17

- **Attractive risk-reward profile at current pricing**: As highlighted in Exhibit 1, historically the trade held to expiry, at current pricing, would have generated an average P&L of 8.4% when positive and -1.8% when negative. The risk-reward looks even more attractive in extreme market outcomes as the max P&L of the trade which is greater than 75% compares to the max loss of only 5.7%. The trade also provides an effective way to gain long exposure to EU equities with limited risks, as evident from the call-like payoff in Exhibit 1 (vs the ESTX50). It is worth noting that, by construction, the maximum loss of the trade is 6.8% with the most likely loss limited to the upfront premium of 1.8%. We also note that the trade payoff profile is superior to a SX5E Dec17 ATM call when sized such that: (i) the call premium is the same as the upfront premium for the dispersion trade (=1.8%, blue line), as well as (ii) when the call premium is the same as the theoretical maximum loss for the trade (=6.8%, orange line).

Exhibit 1: Hypothetical back-test of long Dec17 105% call on a basket of SAN, BNP, ING, ISP & DBK, short Dec17 ATM worst-of call on the same basket (upfront premium = 1.8%)



Source: BofA Merrill Lynch Global Research. Data: 3-Jan-00 to 16-Jun-17. Back-testing is hypothetical in nature & reflects application of the strategy prior to its introduction. It is not actual performance & is not intended to be indicative of future performance. The two call payoff diagrams shown in the chart correspond to SX5E Dec17 3575 strike call sized such that upfront premium = 1.8% (0.46x notional, blue line, equal to the upfront premium for the trade) and 6.8% (1.7x notional, orange line, equal to potential max loss of the trade)

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Notable trends and dislocations (Europe)

European equities ended the week lower mainly due to a tech-driven sell-off on 12-Jun during which the SX8P (European tech sector) witnessed its largest 1-day decline since the UK's EU referendum. Nevertheless, implied vols across European indices remained mostly unchanged near 2 year lows.

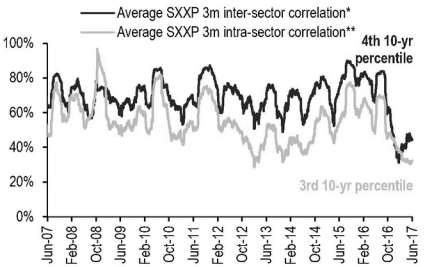
- **European intra-sector correlation continues to decline while inter-sector correl has hit a floor:** The average EU intra-sector 3m correlation is near a 10-year low currently. In contrast, the average 3m inter-sector correlation reached a 10-year low in Mar-17 driven by post US election reflation trades but is now rising off its lows likely driven by an unwind of reflation trades.
- **SX7E implied-realised correlation near 5-year highs:** SX7E 6m implied correlation fell since Mar-17 but the implied-realised correlation spread remains in the 88th 5-year percentile driven by even lower realised correlation.
- **ESTX50 3M put skew is near 5 year highs**, in stark contrast to SXEP (European Oil & Gas equity) put skew which is close to 5 year lows.
- The overall seasonality in ESTX50 realised volatility since 1987 has been one of relatively lower vol during the summer months vs. autumn. In particular, **May stands out as the lowest vol month across most 10 year horizons**, and this also appears to be the case so far this year.

EU intra-sector correl continues to decline while inter-sector correl is supported

The average European intra-sector 3m correlation is near a 10-year low, partly driven by divergence within the personal & household goods, utilities, real-estate, autos and insurance sectors (Chart 18 and Table 3). Interestingly, the average 3m inter-sector correlation reached a 10-year low on 14-Mar-17 (as the 8-Nov-16 US election led to the outperformance of sectors sensitive to inflation) but inter-sector correlation now seems supported likely driven by the unwind of reflation trades (Chart 18).

HOUSE_OVERSIGHT_014982

Chart 18: European intra-sector realised correlation is near a 10-year low, which suggests that we are currently in a stock pickers environment



Source: BofA Merrill Lynch Global Research. 3m correlations calculated using daily returns and assuming current weights. Data from 16-Mar-07 to 16-Jun-17. *Average correlation between each of the 19 SXXP sector indices and the other SXXP sector indices. **Average of the 19 intra-sector correlations (in Euro) where the 19 sector indices are the indices which make up the SXXP index. Note that the average intra-sector correlation calculated using returns in local currencies is also near a 10-year low (2nd 10-yr percentile).

Table 3: Personal & household goods, utilities, real-estate, autos and insurance are the top 5 sectors with the lowest 10-yr percentile of intra-sector 3m realised correlation

		Intra-sector 3M correl	
Sector ticker	Sector name	Level	10yr %-ile
SXQP	Pers. & Hous. Goods	17%	0%
SX6P	Utilities	24%	1%
SX86P	Real estate	40%	1%
SXAP	Autos	41%	1%
SXIP	Insurance	32%	1%
SXRP	Retail	19%	4%
SXTP	Travel	26%	5%
SXFP	Financials	28%	5%
SX4P	Chemicals	28%	6%
SXNP	Industrials	30%	7%
SXPP	Basic res.	50%	11%
SXDP	Health care	24%	11%
SXMP	Media	27%	12%
SXOP	Construction	39%	13%
SXKP	Telcos	32%	14%
SXEP	Oil & Gas	42%	21%
SX7P	Banks	47%	23%
SX3P	Food & bev	31%	25%
SX8P	Tech	35%	35%

Source: BofA Merrill Lynch Global Research. 3m correlations calculated using daily Euro returns and current weights. Data from 16-Mar-07 to 16-Jun-17.

SX7E implied-realised correlation near 5 year high, driven by stock-level divergence

SX7E 6m implied correlation has fallen since Mar-17 but the implied-realised correlation spread remains in the 88th 5 year percentile (Chart 19). Notably, the low SX7E 6m realised correlation in 2017 was mostly driven by company-specific rather than region-specific divergence (Chart 20).

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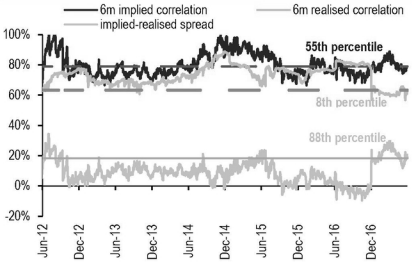
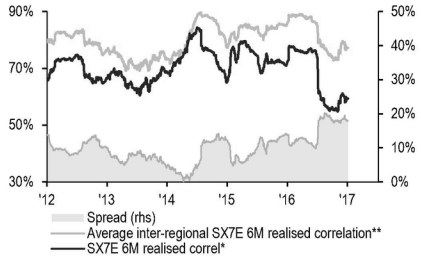
Chart 19: The SX7E 6m implied-realised correlation spread has been high throughout 2017 and remains in the 88th 5-year percentile



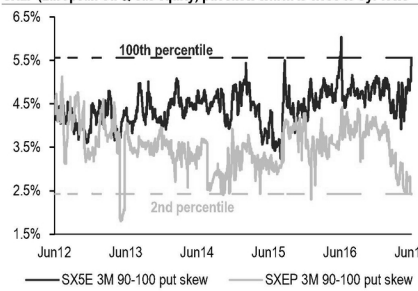
Source: BofA Merrill Lynch Global Research. Data: 16-Jan-12 to 16-Jun-17. Implied and realised correlations are calculated using current weights.

Chart 20: The decline in SX7E 6M realised correlation appears to be mainly due to company-specific rather than region-specific divergence



Source: BofA Merrill Lynch Global Research. Data: 16-Jan-12 to 16-Jun-17. *Calculated based on current weights of French, German, Italian and Spanish banks with enough price history. **We construct theoretical portfolios consisting of SX7E names from a given country (France, Germany, Italy and Spain) and compute the average pairwise correlation of their daily returns

Chart 21: ESTX50 3M put skew is near 5yr highs, in stark contrast to SXEP (European Oil & Gas equity) put skew which is close to 5yr lows



Source: BofA Merrill Lynch Global Research. Data: 16-Jun-12 to 16-Jun-17.

ESTX50 put 3M 90-100 (%fwd) put skew has re-steepened to near 5 year highs following the flattening which ensued after the first round of the French presidential elections (23-Apr). The recent ESTX50 skew dynamics are in stark contrast to what has been witnessed in the SXEP (European Oil & Gas equity), where the 3M 90-100 volatility spread has been trending lower and is currently near-flattest in 5 years.

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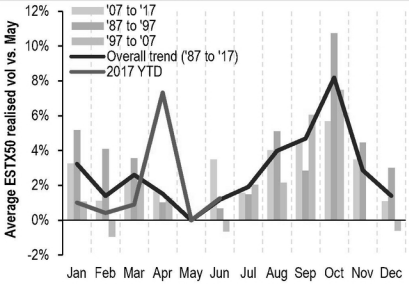
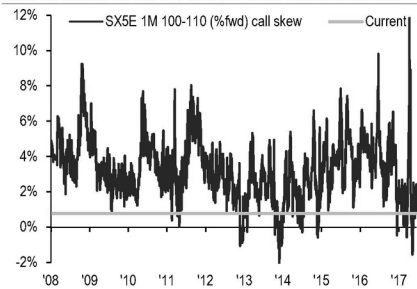
Chart 22: May has typically been the month with the least amount of ESTX50 realised volatility. This has also been true in 2017 thus far



Source: BofA Merrill Lynch Global Research. Data: 1-Jan-87 to 16-Jun-17.

The overall seasonality in ESTX50 realised volatility since 1987 (ESTX50 inception) has been one of relatively lower vol during the summer months vs. autumn. In particular, May stands out as the lowest vol month across most 10 year horizons, and this also appears to be the case so far this year. We note that Apr-17 vol stands out mainly due to the 4% ESTX50 move on the Monday following the first round of the French presidential elections.

Chart 23: ESTX50 1M 100-110 call skew is near-flattest since 2008



Source: BofA Merrill Lynch Global Research. Data: 2-Jan-08 to 16-Jun-17.

ESTX50 short-dated (1M) 100-110 (%fwd) call skew has flattened considerably since pre-French election (23-Apr) levels and currently stands near 9 year+ lows. Consequently, limited upside structures (e.g., call spreads) price attractively both from an ATMf volatility and skew basis.

Table 4: Volatility measures of major equity indices in the EMEA region (data as of 16-Jun-17)

	3Mth ATM implied volatility			10D realised volatility			12Mth–3Mth ATM i-vol spread			3Mth 90-110 skew			Equity index
	Current	Weekly change	2Yr percentile	Current	Weekly change	2Yr percentile	Current	Weekly change	2Yr percentile	Current	Weekly change	2Yr percentile	Weekly return
ESTX50	13.4%	0.3%	2%	9.6%	2.0%	17%	3.4%	-0.2%	99%	8.4%	0.9%	72%	-1.2%
FTSE	10.0%	-0.4%	1%	8.6%	1.1%	24%	3.6%	0.2%	100%	6.2%	0.2%	9%	-0.8%
DAX	12.6%	0.3%	1%	12.7%	2.9%	29%	3.9%	-0.2%	100%	8.5%	0.7%	67%	-0.5%
CAC	13.3%	0.3%	3%	10.3%	2.0%	21%	2.6%	-0.1%	100%	8.6%	1.2%	77%	-0.7%
SMI	11.4%	-0.1%	3%	12.2%	3.3%	44%	2.4%	-0.1%	96%	6.5%	0.1%	27%	1.3%
RDXUSD	25.9%	0.9%	29%	16.2%	-1.2%	17%	0.9%	-0.4%	58%	5.2%	0.4%	27%	-3.7%
TOP40	16.9%	1.3%	17%	10.6%	0.2%	15%	1.7%	-0.5%	47%	8.0%	0.4%	36%	-3.0%
ISE30	20.2%	0.4%	6%	10.1%	-1.4%	5%	3.1%	-0.3%	81%	6.9%	0.1%	74%	-0.8%

Source: BofA Merrill Lynch Global Research

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European volatility: Sector snapshot

Table 5: Volatility measures and indicative option prices for major European sector indices (data as of 16-Jun-17)

					Bearish <<<< ---------- >>>> Bullish											
	3Mth ATMf implied volatility			Real vol*	3Mth 95%-85% put spread**				3Mth 100%-110% call spread**				3Mth 90%-110% risk reversal**			Equity index
	Current	Weekly change	2Yr %-ile	Current	Current price (% of spot)	Weekly change (bps)	2Yr %-ile	Max payout ratio	Current price (% of spot)	Weekly change (bps)	2Yr %-ile	Max payout ratio	Current price*** (% of spot)	Weekly change (bps)	2Yr %-ile	Weekly return
SX3P (Fd&Bv)	10.7%	-0.4%	2%	10.1%	0.6%	-5	2%	16.4	2.1%	-8	7%	4.8	-0.2%	5	80%	1.3%
SX6P (Utils)	12.2%	0.0%	4%	10.9%	0.8%	2	4%	12.8	2.4%	1	5%	4.2	-0.3%	0	95%	-0.1%
SX7E (Banks)	22.7%	0.3%	2%	18.6%	1.9%	2	3%	5.4	3.6%	2	9%	2.8	-0.5%	0	52%	-3.0%
SX7P (Banks)	18.5%	-1.2%	2%	13.1%	1.5%	-10	3%	6.8	3.2%	-15	5%	3.2	-0.4%	10	86%	-1.9%
SXAP (Auto)	16.7%	-1.2%	1%	11.7%	1.3%	-12	1%	7.8	3.0%	-13	1%	3.3	-0.4%	6	68%	-0.7%
SXDP (Health)	13.0%	-0.8%	1%	8.7%	0.9%	-9	2%	11.5	2.5%	-12	3%	4.0	-0.3%	4	71%	0.0%
SXEP (Oil&Gas)	15.4%	0.0%	3%	11.8%	1.2%	0	3%	8.5	2.8%	2	2%	3.6	-0.2%	-2	97%	-1.3%
SXIP (Insur)	14.0%	-0.9%	1%	9.4%	1.0%	-10	1%	10.0	2.7%	-11	1%	3.7	-0.4%	6	83%	1.0%
SXKP (Telecom)	15.4%	0.3%	3%	11.1%	1.1%	3	3%	8.8	2.8%	5	5%	3.6	-0.3%	-3	83%	-1.3%
SXNP (Indust)	16.3%	0.1%	13%	10.9%	1.2%	1	23%	8.1	2.8%	1	10%	3.6	0.0%	0	100%	-0.3%
SXPP (Basic)	23.8%	-0.7%	3%	17.8%	2.0%	-7	3%	5.1	3.5%	0	4%	2.9	-0.3%	-7	53%	-4.8%
SXQP (Prsnl&HH Gds)	10.2%	0.0%	1%	7.2%	0.5%	-1	2%	18.5	2.0%	-1	1%	4.9	-0.3%	1	76%	0.3%
SXRP (Retail)	13.2%	0.4%	10%	12.8%	0.9%	8	10%	11.3	2.5%	14	10%	4.0	-0.1%	-10	78%	-3.3%
SXTP (Trvl&Lsre)	14.4%	0.0%	7%	11.6%	1.0%	1	7%	9.9	2.7%	0	8%	3.7	-0.3%	1	41%	0.5%

Source: BofA Merrill Lynch Global Research *Real vol = EWMA (Exponentially Weighted Moving Average) volatility, which measures historical price volatility but assigns greater importance to recent returns. Sigma(t)^2 = 0.94*Sigma(t-1)^2+(1-0.94)*r(t)^2, where r(t) is the return on day t. **Indicative mid prices; strikes as % of forward ***Negative values indicate that the bullish risk reversal takes in a credit.

HOUSE_OVERSIGHT_014986

Volatility in Asia

Long HSCEI-SPX volatility spread via corridor variance

Global synchronized monetary tightening is positive for EM vol

Emerging markets have been the biggest beneficiaries of the central bank-fueled abundance of liquidity. However, we think the tide may be turning as last week, the Fed, ECB, and BOE all delivered policy announcements with hawkish tones. How far they really go to tighten policy when economic data is weakening still remains unknown. However, we think the uncertainty surrounding tightening will be more positive for EM volatility than for DM volatility.

Chinese banks: Rapid increase in leverage is a big concern

The HSCEI currently has a 70% weight in the financial sector. Recently, BofAML analyst Winnie Wu turned very bearish on the sector as (1) leverage has rapidly increased—debt to GDP rose by 18% in 2016 and may go above 300% by 2019, (2) shadow banking has become too big, too complicated, and too levered to easily regulate—even at the highest quality bank, China Merchants, off-balance sheet wealth management products (WMP) have grown to 40% the size of on-balance sheet assets from just 18% two years ago, and (3) excessive home price inflation—low and middle-income households are late to the party and a correction in prices could have a systemic effect as property assets have been used as collateral in WMPs.

SPX: The Fed is now "collaring" the market

Since the global financial crisis the Fed has been well known for providing a put option by its willingness to step in during periods of market stress. However, post the Fed meeting last week, it appears the central bank has decided to cap its monetary support as some FOMC members seem worried that financial conditions are too loose. Effectively, the market is now "collared" (more so for the SPX compared to EM) as the downside is protected by the Fed put (though with a lower strike price) while the upside is capped by log-jammed fiscal policy and positioning, where the risk of quant funds selling record equity positions meets cashed-up investors still accustomed to buying-the-dip.

The depressed implied China vs. US risks should reverse

With the steep drop in global risk premium, the HSCEI-SPX 18-month variance swap spread has fallen back to the lower-end of its 5-year trading range. Since we believe the global synchronized monetary tightening will impact HSCEI volatility more than SPX volatility, we recommend owning HSCEI-SPX 70/110% corridor variance at 5 vol points, a 3 vol point discount to vanilla variance spreads. Investors will be exposed to the realized vol spread between HSCEI and SPX as long as HSCEI stays within 70-110% of its initial level. Pricing of corridor variance is cheaper than vanilla variance as investors can avoid paying for the rich HSCEI convexity below the 70% barrier. The trade has a positive carry and benefits during China risk-off events.

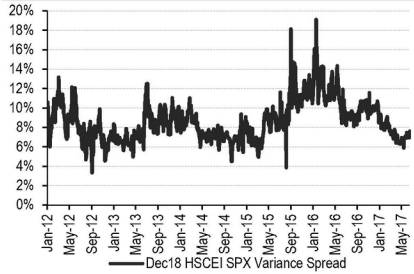
Note that the potential HSCEI index enhancement will reduce the financial weightings in HSCEI from 70% to 50% and lower realized volatility by 1.8 vol points. However, the enhancement will be implemented in stages. It will probably start in Dec-17 at the earliest and will not be fully implemented by the end of 2018, in our view.

Indicative pricing (As of 19-Jun-17)

Buy HSCEI-SPX Dec-18 70/110% corridor variance swap: 5 vol points

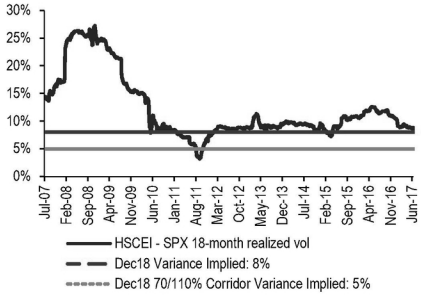
HOUSE_OVERSIGHT_014987

Chart 24: The HSCEI-SPX Dec-18 (18-month) variance swap spread is back to the lower-end of its 5-year trading range



Source: BofA Merrill Lynch Global Research Data as of 2-Jan-12 to 16-Jun-17
18-month constant maturity variance swap spread is used as a proxy of Dec18 variance swap spread

Chart 25: The long term HSCEI-SPX realized vol spread has been higher than the current implied corridor variance spread (5%) 98% of the time since 2007



Source: BofA Merrill Lynch Global Research Data as of 2-Jul-07 to 16-Jun-17

Chart 26: Historical payoff of buying HSCEI-SPX Dec-18 70/110% corridor variance spread; higher payoffs during 2011-2012 and 2015 sell-offs

Source: BofA Merrill Lynch Global Research Data as of 2-Jul-07 to 16-Jun-17

Table 6: The HSCEI-SPX Dec-18 70/110% corridor variance trade has a positive carry with realized vol across most tenors higher than the current implied corridor variance swap spread

	HSCEI	SPX	Spread
1M realized vol	12.1%	4.6%	7.5%
3M realized vol	13.7%	6.8%	6.9%
6M realized vol	14.0%	6.8%	7.2%
12M realized vol	16.6%	9.7%	6.9%
18M realized vol	20.8%	11.99%	8.8%
HSCEI – SPX Dec18 70/110% corridor variance offer:			5.0%

Source: BofA Merrill Lynch Global Research

HOUSE_OVERSIGHT_014988

Notable trends and dislocations (Asia)

Most regions in Asia reported modest declines last week, led by Hong Kong's HSCEI, which lost 2.0% week-over-week. Much of the decline came on Thursday following the US Fed's decision to hike rates 25bps. Also in China, the People's Bank of China (PBOC) injected 410bn yuan (about $60bn) into the financial system via reverse-repos, the largest cash boost since January. The central bank said the funds are meant to ease concern amid a seasonal funding squeeze. The biggest contributors to the index's loss were financials names, including China Life Insurance (2628 HK), which fell 5.7%, Ping An Insurance Group Co of China Ltd (2318 HK), which dropped 3.7%, Bank of China Ltd (3988 HK), which declined 1.8%, and China Merchants Bank Co Ltd (3968 HK), which fell 5.7%. We saw a similar decline from Hong Kong's HSI index, which lost 1.6% percent last week.

After the HSCEI and HSI, last week's biggest losers were Korea's KOSPI and India's NIFTY, which each returned -0.8% week-over-week. In Japan, the Nikkei fell 0.3%. On Friday, the Bank of Japan (BoJ) left its monetary policy unchanged—it will continue to control the yield curve via its negative benchmark rate and its asset purchasing program. The final region to report a loss last week was Taiwan's TWSE, which lost 0.4%.

On the other hand, the only region to see a gain last week was Australia, which saw its ASX 200 benchmark increase 1.7% week-over-week. The biggest contributors to the gain were Commonwealth Bank of Australia (CBA AU), which gained 3.4%, Westpac Banking Corp (WBC AU), which increased 1.9%, and CSL Ltd (CSL AU), which added 2.9%.

10 day realized vol picked up in Asia last week, up 2.0 vol points to 9.6%

- Asian 3m ATM volatility declined on average 0.1 vol point to 12.3% last week, while 10 day realized vol increased on average 2.0 vol points to 9.6%. Notably, the HSI's realized vol increased 5.4 vol points, the biggest increase in the region. On the other hand, the NKY was the only index to see a decline in 10 day realized vol—it dropped 4.3 vol points week-over-week to 7.2%.

- On average, term structures among Asian indices steepened by 0.2 vol points to 4.2% last week. The TWSE 12M-1M term structure steepened the most, increasing 1.0 vol point to 2.9%. On the other hand, Hong Kong's HSI saw the only flattening as its term structure flattened 0.1 vol point to 4.9%.

- Asian 3M 90-110% skews widened 0.5 vol points on average to 3.8%. Taiwan's TWSE widened the most, increasing 2.3 vol points to -0.2%.

Table 7: Volatility measures of major Asian indices (data as of 16-Jun-17)

	3Mth ATM Implied Volatility			10D Realized Volatility			12Mth-1Mth ATM Vol Spread			3Mth 90-110 Skew Spread			Equity Market
	Current	Weekly change	4Yr percentile	Current	Weekly change	4Yr percentile	Current	Weekly change	4Yr percentile	Current	Weekly change	4Yr percentile	Weekly return
HSI	12.4%	0.2%	2.1%	10.2%	5.4%	20.6%	4.9%	-0.1%	97.8%	3.3%	0.9%	41.4%	-1.6%
HSCEI	15.0%	-0.4%	0.0%	10.7%	4.8%	7.8%	5.4%	0.2%	98.1%	1.4%	0.5%	36.5%	-2.0%
NKY	13.8%	-0.2%	0.1%	7.2%	-4.3%	1.8%	5.8%	0.5%	99.9%	5.8%	0.0%	73.9%	-0.3%
KOSPI 200	12.2%	0.2%	19.7%	11.1%	1.1%	53.1%	4.0%	0.2%	77.0%	3.8%	0.3%	43.7%	-0.8%
ASX 200	11.8%	-0.2%	17.7%	15.7%	5.1%	77.1%	2.7%	0.0%	59.5%	6.4%	-0.1%	22.5%	1.7%
NIFTY	10.7%	0.2%	2.2%	4.8%	1.0%	0.4%	4.0%	0.0%	76.1%	5.9%	-0.1%	64.1%	-0.8%
TWSE	10.5%	-0.6%	7.2%	7.8%	1.0%	20.3%	2.9%	1.0%	71.2%	-0.2%	2.3%	3.9%	-0.4%

Source: BofA Merrill Lynch Global Research

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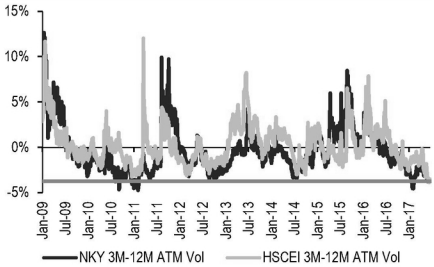
Chart 27: Both HSCEI and NKY term structures are near record steeps; we favor calendar puts to hedge downside risks



Source: BofA Merrill Lynch Global Research Data as of 2-Jan-09 to 16-Jun-17

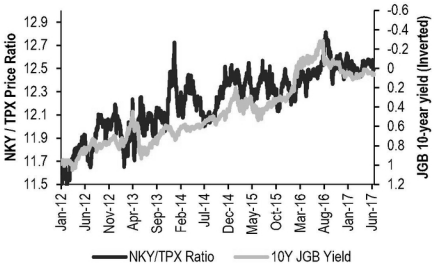
Calendar puts are attractively priced given the steep term structure

With the continuous low realized volatility environment, both NKY and HSCEI 3-month minus 12-month term structures steepened to -3.7 vol points, which are near multi-year lows.

As our strategists think the Fed now appears concerned about surging asset prices, investors should consider downside hedges. Calendar puts, i.e. buying short-dated ATM puts and selling long-dated OTM puts, are attractively priced given the steep term structure.

Currently, we still have an open trade on NKY calendar puts (buy Jul-17 19,500 puts vs sell Dec-17 17,500 puts) to hedge downside risks.

Chart 28: The Nikkei/Topix ratio and its volatility is capped with the BoJ's ongoing yield curve control



Source: BofA Merrill Lynch Global Research Data from 2-Jan-12 to 16-Jun-17

The BoJ's ongoing yield curve control has capped the Nikkei/Topix ratio and its volatility

Japanese government bond (JGB) yield has been on a downward trend over the last few years and has negatively impacted bank earnings. As the Topix has higher weightings in banks than the Nikkei, the NKY/TPX ratio has been grinding higher.

However, the NKY/TPX ratio appears to have flattened out since the BoJ's commitment to maintain the 10-year JGB yield at around 0% in September 2016. With global central banks increasingly advocating tighter monetary policies, the market may start to speculate BoJ's exit strategy and this may reverse NKY/TPX's upward trend. With TPX vol trading below NKY vol, buying TPX calls funded by NKY calls may perform well in such a scenario.

AS51 3M ATM IV over HSCEI is at its 4-year high

Table 4 lists Asian index pairs with the highest IV ratio vs their 4-year histories. For instance, the ratio of AS51 3M ATM IV over HSCEI is at its 4-year high.

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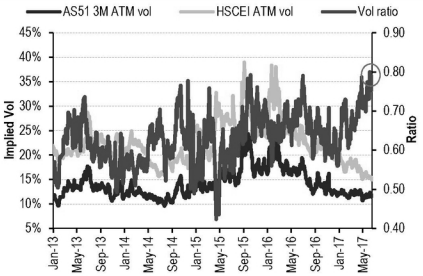
Chart 29: The ratio of AS51 3M ATM IV over HSCEI is at its 4-yr high (Daily data from 1-Oct-12 through 16-Jun-17)



Source: BofA Merrill Lynch Global Research

Table 8: Index pairs^ with the highest implied vol ratio vs their histories (data as of 16-Jun-17)

	Index A (Implied vol)	Index B (Implied Vol)	A/B Implied Vol ratio	Ratio 4-yr percentile
3M ATM	AS51 (11.8%)	HSCEI (15.0%)	0.79	100%
6M ATM	KOSPI2 (13.2%)	HSCEI (17.1%)	0.77	98%
12M ATM	KOSPI2 (14.6%)	NIFTY (14.0%)	1.04	98%
3M 25d-Put	AS51 (13.8%)	HSCEI (16.3%)	0.85	99%
6M 25d-Put	KOSPI2 (14.4%)	HSCEI (18.7%)	0.77	98%
12M 25d-Put	KOSPI2 (16.0%)	HSCEI (20.5%)	0.78	99%
3M 25d-Call	AS51 (10.9%)	HSCEI (15.0%)	0.73	99%
6M 25d-Call	KOSPI2 (12.8%)	NKY (14.4%)	0.89	98%
12M 25d-Call	KOSPI2 (14.2%)	NIFTY (12.2%)	1.16	98%

Source: BofA Merrill Lynch Global Research

^ Index universe includes the ASX200, HSCEI, HSI, KOSPI2, NIFTY, NKY, TWSE, SPX and SX5E

* mid level implied vol

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Summary of Open Trades (19-Jun-17)

Price data for open level reflects the price on open date and does not necessarily reflect the price at which the trade could be executed at the date of this report. Our trades are structured to be executed on the open date and are not necessarily appropriate to execute as formulated beyond that date.

Table 9: Summary of open trades as of 19-Jun-17

Trade Description	Open Date	Open Level	Expected Trade Term	Rationale
Long SX5E vs short SPX Dec18 var swap	5-Jul-16	6.1 vols		Investors should re-assess attractiveness of popular and (typically) technically motivated longer-dated RV vol trades, given environment of structurally higher political & economic risks and increasingly limited policy options
Long NKY vs short SPX Dec18 var swap	5-Jul-16	5.7 vols	Dec-18 expiry	
Long SX5E vs short SPX Dec18 put vs put	5-Jul-16	0.00%		
Buy a 1Y ATM worst-of call on SPX & TLT	18-Jul-16	0.9%	1 year	Cheap equity upside in a bond / equity melt-up
Buy SPX>UKX Jun17 ATM outperformance call, conditioned on SPX lower at maturity (qUSD)	17-Oct-16	2.0%	Jun-17 expiry	Risks of a hard Brexit rising and (weak) currency tailwind likely to prove short-lived; position cheaply for FTSE 100 (UKX) underperformance
Buy UKX Jun17 6650 put, sell SPX Jun17 1850 put	17-Oct-16	2.6%	Jun-17 expiry	
Buy an SX5E Sep-17 95% put conditional on EUR 10Y CMS > 1.1% or < 0.3% in Mar-17	14-Nov-16	2.7%	Sep-17 expiry	Remain long equities and cheapen hedges by conditioning on rates
Buy 2823 HK Jun-17 90/110 strangle	21-Nov-16	5.55%	Jun-17 expiry	China risk premium rising but A-shares vol still at all-time lows
Buy ESTX50 Dec17 90% put contingent on EURGBP < 0.82 by Jun17 expiry	2-Dec-16	1.63%	Dec-17 expiry	Equity-FX correlation is not priced for a spillover of populism into the EU, which could cause EUR to fall against an already weakened GBP as equities fall
Buy SPX>UKX Jun17 5% outperformance call (qUSD)	2-Dec-16	2.05%	Jun-17 expiry	UKX is heavily exposed to EU (50% revenues) and should underperform SPX if GBP tailwind fades. Volatility & correlation suit well for outperformance
Long XLF vs SX7E Jun17 ATM outperf call, contingent on SX7E higher at Jun expiry (qEUR)	2-Dec-16	1.20%	Jun-17 expiry	Cheapen long XLF upside to near 8y lows via selling upside on structurally challenged European banks & relatively more bearish outlook for US rates vs EU
Buy NKY Jun17 110% Call	02-Dec-16	1.83%	Jun-17 expiry	USDJPY and NKY the biggest beneficiaries of a Trump win
Buy TPINSU Jun17 110-125% Call Spread	02-Dec-16	3.30%	Jun-17 expiry	Banks and Insurance are the most leveraged sector
Buy TPNBNK Jun17 110-125% Call Spread	02-Dec-16	3.20%	Jun-17 expiry	Banks and Insurance are the most leveraged sector
Buy 2823 HK Jun17 90/110% strangle	02-Dec-16	5.90%	Jun-17 expiry	China risk premium rising but A-shares vol still at all-time lows
Buy HSCEI Jun17 105-120% call spread contingent on $KRW >1200	02-Dec-16	1.20%	Jun-17 expiry	Own contrarian EM upside at low cost & limited risk
Buy NKY-SPX Dec19 70/110% corridor variance	02-Dec-16	1.50%	Dec-19 expiry	QE uncertainty and USDJPY vol support NKY vs SPX realized vol
Buy NKY Jun17-Jun18 18,500 strike FVA	02-Dec-16	21.5%	Jun-17 expiry	What if QE hits its limit? Long NKY vol outright which is cheap to carry
Long Russell 2000 vs. short S&P 500 Dec-18 var spread	5-Dec-16	3.9pts	Dec-18 expiry	With fiscal stimulus and potential tax cuts, small caps revert to old normal generating higher vol on upside and downside relative to large caps
Buy 1x Jun17 64 call on Aug17 Brent futures, sell 1x SXEP Jun17 330 call	9-Jan-17	1.00%	Jun-17 expiry	Vol and price technicals are attractive. BofAML commodity strategists oil target is $70/bbl but this is already priced in SXEP levels according to BofAML Oil & Gas equity analysts
Buy SPX 6m ATM call contingent on GLD 5% higher in 3m	23-Jan-17	1%	Jul-17 expiry	Position for a near-term wobble followed by yet another equity melt up
Long NKY - SPX Dec-18 corridor var replication	13-Feb-17	4.00%	Dec-18 expiry	Cheaply access positive carry QE failure hedge
Buy NDX Top20 volatility dispersion	27-Feb-17	17.0%	Jan-18 expiry	
Long 1.8x vega on 1y single stock vols of UK Brexit exposed names, Short 1x vega on 1y FTSE index vol	14-Mar-17	32.3vols	14-Mar-18	Position for a pick-up in single stock realised vol on the 10 names (within FTSE's top 30) where post EU referendum realised vol was the highest relative to current 1y ATMf vol. The 10 names are: Barclays, Aviva, Prudential, BT, Glencore, Tesco, CRH, BA, Standard Chartered & HSBC.
SPX Sep-17 95% puts conditional on the 5yr CMS rate above 2.4% at maturity	14-Mar-17	1%	Sep-17, expiry	Hedge portfolios against a buy-the-dip failure should a faster rate cycle ultimately jeopardize it
Buy Buy-Rated MSCI A-shares stocks & hedge with puts	23-Mar-17	1.44%	Jun-17 expiry	Market may trade on the MSCI inclusion theme; Hedge with 2823 HK Jun17 95% put
Buy A-shares with highest MSCI impact & hedge with put	23-Mar-17	1.44%	Jun-17 expiry	Market may trade on the MSCI inclusion theme; Hedge with 2823 HK Jun17 95% put
Own Japan stock vol via gamma weighted vol dispersion	10-Apr-17	15.8%	Mar18 expiry	Historically attractive to own TOPIX Top 10 corridor gamma weighted volatility dispersion
Buy CNOOC Jul-17 95% puts vs. sell HSCEI 95% puts	24-Apr-17	0.77%	Jul17 expiry	Hedge a rollover in China GDP and screen for cyclicals that could face pressure
Buy CH Merchant Bk Jul-17 18.5/17 put spread vs 22 call	24-Apr-17	0.10%	Jul17 expiry	Hedge a rollover in China GDP and screen for cyclicals that could face pressure
Buy SX5E Dec17 3800 calls contingent on EURUSD > 1.1 at expiry	8-May-17	1.3%	Dec17 expiry	Benefit from low vol, flat correl, likely hawkish ECB & (FX un-hedged) inflows into EU equities
Buy 1.5x KOSPI2 285 puts vs. short 1x $KRW 1160 call	8-May-17	0.3%	Jul17 expiry	Leverage inexpensive equity vs. FX vols to own cheap tail protection
Buy EEM Aug17 39.5 put and sell EEM Aug17 37 put	15-May-17	1.6%	Aug17, expiry	Buy inexpensive EM equity puts on near-record performance gap to commodities
Buy Dec17 105% call on an equally weighted basket of SX7E, SXAP, SXPP & SXEP, sell Dec17 ATM worst-of call on the same	15-May-17	1.6%	Dec17 expiry	Monetise low vol & high implied correl to position for greater sector dispersion in EU: long basket call, short worst-of call
Buy NKY Jul-17 19500 puts vs. short Dec-17 17500 puts	15-May-17	0.0%	Jul17 expiry	Own inexpensive NKY hedges into FOMC; Term structure is too steep is under-pricing risks
Short GILD $55-$62.5-$67.5 put spread collar	16-May-17	1.5%	Sep-17 expiry	Buy out-of-favour and inexpensive biotech upside by levering depressed vol & skew
Long 1x EEM 3m 97.5% put vs. short ~0.09x units each of 3m 97.5% puts on FXI, EWY, EWZ, EPI, EWT, RSX, EZA, and EWW	1.5%	0.0%	3m	Buy EEM puts financed by a basket of EM puts to lever near record low correl
Buy Tencent Jul17 250/300 strangle	22-May-17	2.45%	Jul-17 expiry	Hedge a potential China tech bubble; Tencent potentially volatile after a 45% rally YTD
Buy A-shares (2823 HK) Jul17 105% call	22-May-17	1.15%	Jul-17 expiry	Hedge the upside into MSCI announcement on 20-Jun
Buy 1x contract of ESTX50 Jun17 3525, sell 4x contracts of V2X Aug future	22-May-17	1.00%	Jun-17 expiry	Fundamental case to be long EU equities remains intact but stretched bullish positioning could lead to near-term consolidation
Buy SX5E Dec17 3450-3700 bullish risk reversal vs short IBOXX HY TRS with equal notional sizing	30-May-17	1.17%	Dec-17 expiry	BofAML Equity & Credit strategists highlight they favour equities over HY credit as div yields have surpassed HY credit yield & equities offer more gearing to rising PMI's, earnings and FCF

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Table 9: Summary of open trades as of 19-Jun-17

Trade Description	Open Date	Open Level	Expected Trade Term	Rationale
Buy 6m ATM calls on FB, AMZN, NFLX and GOOGL	30-May-17	6.9% (FB), 7.2% (AMZN), 9.4% (NFLX), 6.2% (GOOGL)	6m	Stock replace FANG stocks
Buy a 6m outperformance call on FANG stocks vs. SPX conditional on SPX> current levels at expiry	30-May-17	3.4%	6m	Lever extremely depressed FANG volatility and low correlation to buy upside
Buy HSI Sep17 90% put, sell ASX200 Sep-17 90% put	30-May-17	0.15%	Sep-17 expiry	HSI is unlikely to outperform if AS51 drops more than 10%; HSI vol below AS51 vol
Buy 14-Sep-17 best-of 95% put on NKY/KOSPI2/HSI	05-Jun-17	0.80%	Sep-17 expiry	Buy best-of puts to hedge a reversal in rally with the low vol and correlation environment
Buy SPX Top50 volatility dispersion	05-Jun-17	16.6%	Jun-18 expiry	Position for a potential bubble in Tech
Buy XLF 24 call, sell QQQ 139 call	12-Jun-17	0.01%	Jul-17 expiry	Rotate out of Growth into Value
Buy NKY-KOSPI2 Dec-17 90/110 strangle spreads	12-Jun-17	3.50%	Dec-17 expiry	We think the technically depressed NKY-KOSPI2 volatility spread will normalize
Buy NKY Sep17 19000-17500 put spread	12-Jun-17	0.93%	Sep-17 expiry	NKY put spread may offer even better value in hedging against a "mini TARP moment"

Source: BofA Merrill Lynch Global Research. Prices reflective of most recently available data which may be delayed in some cases. "Trade Value" represents current valuation of trades initiated on the "Open Date".

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Summary of Closed Trades (19-Jun-17)

Table 10: Summary of closed trades as of 19-Jun-17

Trade Description	Open Date	Open Level	Close Level	Close Date	Rationale
Buy NKY Aug-16 105%-110% call spreads & sell 90% puts	11-Jul-16	0.26%	1.73%	25-Jul-16	Close position as the hurdle to surprise on the upside is high following a 5.8% NKY rally
Replace FB long positions via Oct-16 ATM calls	25-Jul-16	5.9%	6.1%	1-Aug-16	Close position as Facebook rallied on better-than expected Q2 results
Replace AMZN long positions via Oct-16 ATM calls	25-Jul-16	5.5%	6.3%	1-Aug-16	Close position as Amazon rallied on better-than expected Q2 results
Buy AAPL Oct-16 ATM protective puts	25-Jul-16	4.6%	1.2%	1-Aug-16	Remove protection as worries around disappointing Q4 guidance faded post earnings
Buy 1.5x 5-Aug-16 2950-3000 strangles by selling 1x 19-Aug-16 2950-3000 strangles	25-Jul-16	0.00%	-1.12%	5-Aug-16	The BoJ, Fed & EU bank stress tests could move mkts sharply in the near term
Sell NKY Aug16 15500 puts, Buy Sep16 15500-14500 put spreads	25-Jul-16	0.24%	0.28%	Aug-16 expiry & Sep-16 expiry	Unwinding before the Aug16 expiry; The NKY Sep put spread has carried well
Buy TLS 25-Aug16 95% puts	18-Jul-16	1.05%	2.95%	15-Aug-16	Telstra has announced earnings and the stock has corrected 5% over the period
Buy Newcrest 25-Aug-16 105/115% call spreads	18-Jul-16	2.64%	1.18%	15-Aug-16	NCM has stayed unchanged over the period despite better than expected earnings
Buy CSL 25-Aug-16 95% puts	18-Jul-16	1.09%	1.18%	22-Aug-16	CSL fell 5.4% over the period with weak earnings announcement
Buy BHP 25-Aug-16 105/115% call spreads	18-Jul-16	2.22%	0.77%	22-Aug-16	BHP rose 3.6% over the period but the option remains out of the money
Buy HSCEI Aug16 9400 call, Short Oct16 10000 call	1-Aug-16	0.00%	0.67%	22-Aug-16	Close position as the HSCEI rallies 5.2% and we are approaching the Aug16 expiry
Buy Tencent (700 HK) Sep16 105% call	15-Aug-16	1.70%	2.70%	22-Aug-16	Tencent jumped post better than expected earnings
Sell 1x SX7E 1M 25d call to fully finance 1.85x SX5E 1M 25d calls	25-Jul-16	0.0%	0.0%	25-Aug-16	SX7E 1M 25d call / SX5E 1M 25d call price ratio is in the 100th 2-yr percentile
Buy CMB (3968 HK) Sep16 105-115% call spread	5-Jul-16	2.32%	6.12%	30-Aug-16	Close position and BofA ML turned neutral in EM in the short-term
Buy ICBC (1398 HK) Sep16 105-115% call spread	5-Jul-16	2.12%	9.0%	30-Aug-16	Close position and BofA ML turned neutral in EM in the short-term
Buy BOC (3988 HK) Sep16 105-115% call spread	5-Jul-16	2.10%	6.28%	30-Aug-16	Close position and BofA ML turned neutral in EM in the short-term
Buy XLF Sep 24 strike call	25-Jul-16	1.4%	2.3%	6-Sep-16	Close positions from trades that have benefited thus far from the rally in Financials and weakness in Utilities; monetize view that Fed will not hike in September
Buy XLU Sep 51 strike put	25-Jul-16	1.3%	2.6%	6-Sep-16	
Buy a 6M ATM worst-of {XLF call, XLU put}	25-Jul-16	1.35%	3.0%	6-Sep-16	
Buy 0.85x SX5E Sep16 3000-3100 strangle, sell 1x SX5E Dec16 3000-3100 strangle	15-Aug-16	-5.07%	-5.73%	Sep-16 expiry	Take advantage of low near term vol and a steep term structure
Long 0.5x V2X Oct16 future, short 0.5x V2X Jan-17 future	11-Jul-16	0.05 vols	-0.95 vols	19-Sep-16	Unwind Oct/Jan spread and maintain Nov/Jan spread given clarity around the Italian referendum date
Sell VSTOXX Sep 21 puts	30-Aug-16	1.20 vols	1.77 vols	Sep-16 expiry	Global macro event risk likely to keep V2X supported going into Sep expiry
VIX Sep 17/22 1x2 call ratios {short 2x) + 0.75x SPY Sep23 210 puts	15-Aug-16	$0.85	$0.45	Sep VIX expiry	Trade provided hedging benefits during the sudden Sep market shock & has expired
Buy NKY Oct 95/105 strangle outright	30-Aug-16	2.28%	0.44%	27-Sep-16	Take a loss post an disappointing market reaction on the BoJ announcement
Buy NKY Oct 95/105 strangle daily delta-hedging	30-Aug-16	2.28%	0.56%	27-Sep-16	Take a loss post an disappointing market reaction on the BoJ announcement
Long 3M 25d EFA put vs short 3M 25d UKX put	5-Jul-16	0.00%	0.00%	3 months	Trade expired on 3-Oct
Replace T long position via 3M ATM calls	19-Jul-16	2.72%	0.04%	3 months	Our analysts no longer expect impactful catalysts in the near term; stock replacement strategies proved useful in cushioning downside losses during the abrupt Sep-16 sell-off vs. long equity positions.
Replace LOW long position via 3M ATM calls	19-Jul-16	3.90%	0.00%	3 months	
Replace RTN long position via 3M ATM calls	19-Jul-16	3.16%	0.41%	3 months	
Replace CRM long position via 3M ATM calls	19-Jul-16	4.16%	0.19%	3 months	
Replace NEE long position via 3M ATM calls	19-Jul-16	2.32%	0.08%	3 months	
Overlay long WBA long position with 3M ATM calls	19-Jul-16	4.04%	1.20%	3 months	
Buy HKEx (388 HK) 1x2 105%-115% call ratio	15-Aug-16	0.60%	0.00%	29-Sep-16	HKEx failed to rally above the first call strike and expired worthless
Buy NKY Oct16 17500 call, Sell 0.65x NKY Sep 17250 call	8-Aug-16	0.70%	0%	14-Oct-16	NKY Oct-16 call expired out of the money
Short VIX Oct 15 put vs. long VIX Nov 19/26 call spread	1-Aug-16	$0.45	$0.88	14-Oct-16	Close position as the Oct VIX future stayed well-supported as is typically the case in the weeks leading up to the US presidential election
Long 2x SPX Oct31 2125 puts vs. short 1x SPX Mar-17 1975 put	6-Sep-16	0.0%	-0.34%	14-Oct-16	Provided hedging benefits in the sudden equity shock in early Sep-16; now being unwound to mitigate decay
DAX +2.31x Dec16 / -1x Dec17 put calendars	30-Aug16	0.00%	-2.60%	Dec-16 expiry	DAX outperformance & low short dated DAX vol make put calendars attractive
Buy SX5E Dec16 2950/2750 put spread	6-Sep-16	1.48%	0.00%	Dec-16 expiry	A catalyst-strewn fall and a remarkably low volatility summer suggests that there could be headwinds to continued market upside on low volatility
Buy 1.5x SX5E Dec16 3100 call, sell 1x SX5E Mar17 3100 call for an upfront credit of 56bps	24-Oct-16	-0.56%	1.62%	Dec-16 expiry	Monetise steep SX5E vol curve for tactical EU upside with an upfront credit
Buy a 6M ATM worst-of call on XLP & GLD	11-Jul-16	1.05%	0.0%	6 months	Take a loss as safe-haven assets post a weak performance in H2-16 with fears over Trump's surprise victory easing and stock markets rallying
Buy a 6M ATM worst-of {SPX put, GLD call}	11-Jul-16	1.60%	0.0%	6 months	
Buy GLD 124/130 Dec-16 call spread	8-Nov-16	0.9%	0.0%	Dec-16	
Buy GLD 116/124/130 Dec-16 call spread collar	8-Nov-16	0.65%	-7.4%	Dec-16	
Buy TLT 123/132/137 Dec-16 call spread collar	8-Nov-16	0.67%	-5.03%	Dec-16	
Buy Oct16 110%F calls on VIE FP, AI FP, IBE SQ, STAN LN and MUV2 GY	18-Jul-16	2.37%	3.30%	Oct-16 expiry	Add exposure via inexpensive upside on single names where positioning appears particularly bearish and stocks have underperformed vs. their sectors
Buy an Oct16 110%F call on an equally weighted basket (quanto EUR)	18-Jul-16	0.81%	0.00%	Oct-16 expiry	
Buy 0.895x V2X Oct 21 puts, sell 1x VIX Oct 16 puts	19-Sep-16	0.0	$1.3	Oct-16 expiry	Near term catalysts & curve differentials favour tactical long V2X, short VIX puts
Sell SX7E Dec16 115 call	6-Sep-16	-0.88%	-1.09%	24-Oct-16	Close short SX7E call (part of SX5E put spread, short SX7E call trade) to limit potential risk from a "Yes" in the Italian referendum

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Table 10: Summary of closed trades as of 19-Jun-17

Trade Description	Open Date	Open Level	Close Level	Close Date	Rationale
Buy HSI Oct-16 102% call, Sell HSP 105% call	19-Sep-16	0.60%	0.00%	28-Oct-16	HSP has under-performed HSI by 1.8% but both options expire out-of-the money
Short 1x USO 3M 25d put, long 2.1x SXEP 3M 25d call	8-Aug-16	0.00%	0.00%	4-Nov-16	The number of long SXEP calls per short USO put is historically high. Leverage commodity and equity strategists' views on oil and the Oil & Gas sector
Sell Dec16 SXDP 635 puts, buy 0.6x Dec16 SX7E 110 calls	7-Nov-16	0.00%	1.23%	11-Nov-16	Tactical option trade ahead of US elections
Long 0.5x V2X Nov16 future, short 0.5x V2X Jan-17 future	11-Jul-16	0.20 vols	-1.19 vols	Nov-16 expiry	Hedge further Brexit fallout, Italian bank & referendum risk.
Buy NIFTY Nov16 95/105 strangle outright	6-Sep-16	1.63%	6.36%	21-Nov-16	Close position as NIFTY has fallen 11.4% and we are approaching the expiry
Buy H-shares w/ SZ-A & buy HSCEI Dec16 put	22-Aug-16	1.90%	8.72%	5-Dec-16	Close position as the Shenzhen HK connect has launched on 5-Dec-16
Buy HK small-cap & buy HSCEI Dec16 put	22-Aug-16	1.90%	6.76%	5-Dec-16	Close position as the Shenzhen HK connect has launched on 5-Dec-16
Buy 1.32x EFA US 3M 25d put, sell 1x SX5E 3M 25d put for near 0 upfront premium	22-Aug-16	0.04%	0.00%	22-Nov-16	Own EFA puts vs ESTX50 puts to benefit from any increase in quantitative failure risk in Japan and post-Brexit uncertainty
Buy 2.6x SX5E 3M 110% call, sell 1x SX5E 3M 90% put for near 0 upfront premium	22-Aug-16	-0.04%	0.00%	22-Nov-16	Low vol, high skew combo makes ESTX50 levered riskies attractive
Sell 1M 95%f SX5E put and buy 1M 105%f SX5E call	31-Oct-16	-0.40%	0.00%	1-Dec-16	Generate income in range-bound markets, benefiting from high ESTX50 skew
Buy KOSPI2 Dec16 95% put, sell $KRW 97.4% put	17-Oct-16	0.00%	0.00%	8-Dec-16	Both legs expire out-of-the money at expiry
Buy HSCEI Dec16 95% put, sell 2822 HK 94.8% put	12-Sep-16	0.00%	0.00%	29-Dec-16	Both legs expire out-of-the money
Buy HSCEI Dec-16 105-115% call spread	27-Sep-16	1.82%	0.00%	29-Dec-16	HSCEI call spread expires out-of-the money
Buy CH Banks Dec-16 105-115% call spread	27-Sep-16	2.05%	0.00%	29-Dec-16	Chinese Banks call spread expires out-of-the money
Buy Best-of TWSE,KOSPI2,HSCEI Dec16 95% put	10-Oct-16	0.90%	0.00%	29-Dec-16	The best performing index (KOSPI2) fell less than 5% over the period
Buy HSCEI Dec16 9800 call with a 10600 knock-out	7-Nov-16	1.00%	0.00%	29-Dec-16	HSCEI knock-out call expires out-of-the money
Sell Samsung Jan17 90% put, buy KOSPI2 96% put	17-Oct-16	0.00%	0.00%	12-Jan-17	Both legs expire out-of-the money. The relative value trade has a zero profit & loss
Buy an XOP Jan-17 45 call	22-Aug-16	1.4%	0.00%	20-Jan-17	Call expired out-of-the money at expiry
Buy an XLE Jan-17 ATM call with 115% knock-in	22-Aug-16	2.5%	0.0%	20-Jan-17	Call expires in-the-money but the barrier was not breached at expiry
Buy an XLE over SPX Jan-17 ATM outperformance call contingent on SPX up at expiry	22-Aug-16	2.3%	3.4%	20-Jan-17	Energy equity outperformed the overall equity market while both were up by the time the outperformance call expired
Buy XLP Jan-17 52 / 49 put spread	19-Sep-16	1.4%	0.00%	Jan-17 expiry	Both legs expire out-of-the money
Buy a 6M ATM best-of put on SPX & TLT	18-Jul-16	0.8%	0.00%	6 months	Put expired out-of-the money as the S&P500 ended
Buy LLY Jan-17 80/90 1x2 CS	17-Oct-16	1.8%	0.00%	Jan-17 expiry	Both legs expire out-of-the money
Buy LLY Jan-17 80/85 CS with 90 KI on upper leg	17-Oct-16	2.4%	0.00%	Jan-17 expiry	Both legs expire out-of-the money
Buy ZTS Jan-17 46/50 bullish risk reversal	17-Oct-16	2.6%	7.4%	Jan-17 expiry	Both legs expire in-of-the money
Buy ZTS Jan-17 46/50/55 call spread collar	17-Oct-16	1.4%	7.4%	Jan-17 expiry	The 46 call and 50 call expire in-the-money
Buy an EWZ Jan-17 40 call	24-Oct-16	3.1%	0.00%	Jan-17 expiry	Call expired out-of-the money at expiry
Buy TPINSU 105-120% call spread, short 85% put	14-Nov-16	1.75%	4.50%	13-Jan-17	Option expired and Topix Insurance rose 9.5% over the period
Buy TPNBNK 105-120% call spread, short 85% put	14-Nov-16	1.85%	10.60%	13-Jan-17	Option expired and Topix Banks rose 15.6% over the period
Buy HSBC Jan-17 105% call, Sell HSP 105% call	14-Nov-16	0.52%	4.98%	26-Jan-17	Option expired; HSBC out-performed HSP on the upside
Buy SX5E +Dec19/-Dec18 div future spread	4-Oct-16	€-7.0	€-4.2	6-Feb-17	Close position given sudden SX5E rally and Dec18 div future will lose equity beta
Own Nifty Mar17 call to position for budget surprise	23-Jan-17	0.67%	2.15%	6-Feb-17	Nifty was up 4.9% over the period on the back of a positive budget announcement
Buy HSI Feb17 23600 call	9-Jan-17	0.48%	1.09%	13-Feb-17	Close position. HSI was up 4.9% over the period
Buy AMP AU 23-Feb-17 95% puts	30-Jan-17	1.85%	0.27%	13-Feb-17	Unwind the put option post the earnings result
Buy SUN AU 23-Feb-17 95% puts	30-Jan-17	1.39%	0.08%	13-Feb-17	Unwind the put option post the earnings result
Buy 1x V2X Feb17 19 calls, sell 0.85x V2X Mar17 futures	17-Jan-17	-16.1v	-14.32v	Feb-17 expiry	Unwind as the Feb17 call expired
Buy CBA AU 23-Feb-17 95% puts	30-Jan-17	0.76%	0.00%	21-Feb-17	Unwind the put option post the earnings result
Overwrite WES AU 23-Feb-17 103% calls	30-Jan-17	-0.87%	-1.20%	21-Feb-17	Unwind the put option post the earnings result
Long V2X Apr future, short V2X May future	9-Jan-17	0.45	4.55	24-Feb-17	The Apr future has already richened significantly vs. the May future. Prefer V2X May long May call spread, short Apr put as a French election hedge instead.
Buy 1x ESTX50 Dec17 3250 calls, sell 1.23x EURJPY Dec-17 115 puts	5-Dec-16	0.00%	3.20%	24-Feb-17	Unwind ahead of French elections as political uncertainty can weigh on the EUR
Buy NKY Dec17 19500 call, short Mar17 18000 call	3-Oct-16	0.58%	-1.82%	3-Mar-17	Unwind the option before the Mar-17 expiry
Buy NKY Mar17-Dec17 17000 strike FVA	3-Oct-16	20.2%	21.6%	3-Mar-17	Unwind the option before the Mar-17 expiry
Buy TPNBNK Mar17 1x1.5 180/170 put ratio	9-Jan-17	0.60%	0.00%	10-Mar-17	Option expired out-of-the money as the TPNBNK remained range-bounded
Buy ESTX50 17-Mar-17 3350-3450 strangle	6-Mar-17	0.80%	0.00%	17-Mar-17	Expired out-of-the-money
Buy Volkswagen 2017 dividend future	17-Jan-17	€1.3	€2.0	14-Mar-17	Volkswagen announced a dividend of €2.05 on 14-Mar-17
Buy Mar17 UKX 6700 put cont. on GBPUSD<1.20	10-Oct-16	0.81%	0.0%	17-Mar-17	
Buy Mar17 UKX<6700 / GBPUSD<1.20 dual digital	10-Oct-16	9.1%	0.0%	17-Mar-17	UKX rallied making the hedges expire out-of-the-money
Mar17 UKX 6700 buy qUSD put, sell 0.9x vanilla put	10-Oct-16	0.44%	0.0%	17-Mar-17	
Buy 6M ATM worst-of {XLF call, XLU put}	19-Sep-16	1.38%	0%	17-Mar-17	While XLF has rallied ~30% since inception, XLU is higher by 4% and the XLU put is the worst performing option, expiring OTM
Buy an SPX Mar-17 97.5% put contingent on USO>105% at expiry	3-Oct-16	1.08%	0%	17-Mar-17	The structure offered a deep discount for an SPX hedge and expires OTM as markets have rallied strongly
Buy a USO Mar-17 105% call contingent on SPX<97.5% at expiry	3-Oct-16	1.70%	0%	17-Mar-17	The trade expires OTM due to the SPX rally and a sell off in oil over the past two weeks
Buy a Mar-17 SPX<97.5%, USO>105% dual digital	3-Oct-16	11.80%	0%	17-Mar-17	The trade expires OTM due to the SPX rally and a sell off in oil over the past two weeks
Buy an IWM Mar-17 ATM call conditional on EEM<95% at expiry	14-Nov-17	1.15%	0%	17-Mar-17	EEM has rallied 15% over the period together with IWM
Buy an XLI Mar-17 ATM call conditional on EEM<95% at expiry	14-Nov-17	0.89%	0%	17-Mar-17	EEM has rallied 15% over the period together with XLI
Buy GLD Mar-17 116 call, sell Jun-17 127 call	23-Jan-17	1%	0.31%	17-Mar-17	While GLD rallied strongly earlier in the life of the trade, it recently retreated at the time of expiry with GLD 87bps above the lower strike, the short call is worth 56bps

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Table 10: Summary of closed trades as of 19-Jun-17

Trade Description	Open Date	Open Level	Close Level	Close Date	Rationale
Long 2x SPX Aug-17 2200 puts, short 1x SPX Aug-17 2350 put	21-Feb-17	0.10%	0.01%	17-Mar-17	SPX has traded range bound since inception of the trade, still the carry has been minimal, close out or roll the position
Own Nifty Mar17 strangle heading into 5 events	23-Jan-17	1.50%	3.96%	20-Mar-17	Unwind the option post the state election event and Close position
Long XLF Jun17 24 call, short SX7E Jun17 120 call	2-Dec-16	0.74%	-5.88%	27-Mar-17	The call vs call relative value trade is now riskier given the potential reversal in US reflation trades and the potential for European equities to rally in a French election market-favourable outcome. Unwind the position for the Tencent earnings
Buy Tencent Mar-17 105% calls	27-Feb-17	1.15%	2.31%	27-Mar-17	
Buy HSCEI Mar17 105% call contingent SPX <2200	24-Oct-16	1.20%	0.00%	30-Mar-17	Option expired; HSCEI was up 5.1% but the SPX ended above 2200
Buy HSCEI Mar17 9600 put vs short Sep17 8200 put	17-Jan-17	-0.05%	-0.78%	30-Mar-17	Unwind post Mar-17 expiry; the short Sep17 put helped reduce the hedging cost
Buy HSCEI Mar-17 1x1.5 10800-11200 call ratio	21-Feb-17	0.57%	0.00%	30-Mar-17	Option expired; HSCEI stayed flat and failed to rally above the 10800 call strike
Long SX5E Apr17 3300 call, short SX5E Dec17 3450 call	30-Jan-17	-0.60%	-0.18%	21-Apr-17	Apr17 option expired so we unwind the entire trade as planned
Short 1x SX5E May17 3350 calls, long 2x SX5E May17 3450 calls	21-Feb-17	0.00%	0.60%	24-Apr-17	Unwind before May expiry following the large 4% SX5E move on 24-Apr, given lack of near term catalysts
Buy an SPX Apr-17 95% put conditional on US 10Y CMS > 2.5% at maturity	14-Nov-16	0.78%	0%	21-Apr-17	In Nov-16, we recommended remaining long equities with cheap hedges. The hedge expires out of the money, while SPX has returned 8.7% for the period
Long SPX Apr17 2300 call, short SPX Dec17 2400 call	30-Jan-17	-0.80%	-0.71%	21-Apr-17	The reflation trade has slowed down and the market is in a holding pattern. The long Apr-17 call expires in-the-money, and the short Dec-17 call still has time value
Long VIX May 16 / 22 call spread vs. short VIX Apr 13 put	21-Feb-17	$0.35	$0.75	19-Apr-17	The call spread still has value due to elevated vol and vol-of-vol and we collect the premium on the expired short OTM put
Short SPX 21-Apr-17 vs. long 28-Apr-17 2325 straddle pair	6-Mar-17	0.50%	1.06%	21-Apr-17	The trade benefited from the rise in post-event volatility relative to pre-event volatility
Buy SX5E 28-Apr-17 3600 call	3-Apr-17	0.26%	0%	28-Apr-17	The option expired
Buy Unicom Apr17 105-115% call spread	21-Feb-17	1.65%	4.25%	27-Apr-17	Single stock option expired in-the-money despite a 1.4% decline in the HSCEI
Buy Sands China Apr17 105-115% call spread	21-Feb-17	2.00%	6.97%	27-Apr-17	Single stock option expired in-the-money despite a 1.4% decline in the HSCEI
Buy Galaxy Apr17 105-115% call spread	21-Feb-17	2.10%	10.0%	27-Apr-17	Single stock option expired in-the-money despite a 1.4% decline in the HSCEI
Buy SX5E Dec19 2500 put, sell SX5E Dec18 2500 put	27-Sep-16	3.97%	1.9%	8-May-17	SX5E has rallied 23.3% since we entered the trade and European political risk abated for now
Buy KOSPI2 May17 103% calls	13-Mar-17	0.63%	5.37%	8-May-17	Option expired; KOSPI2 rallied 8.37% over the period
Buy KOSPI2 May17 97/103% strangle	13-Mar-17	1.38%	5.37%	8-May-17	Option expired; KOSPI2 rallied 8.37% over the period
Buy NKY Jun17 20750 call, sell 1-1.3x 18750-17750 put ratio	06-Mar-17	0.00%	0.00%	15-May-17	Closing the trade post French election; option strikes remain far from the spot level
Long V2X May 26-32.5 call spread and short Apr 22 put	21-Feb-17	€0.20	€0.00	19-May-17	Expired
Buy 1x contract of SX5E May17 3550 call, sell 5x contracts of V2X May17 16 puts	3-Apr-17	0.0%	-1.63%	19-May-17	Expired
Long GLD May 123 call vs. short May 130 call	21-Feb-17	0.8%	0.00%	19-May-17	The hedge expired out-of-the-money as S&P 500 remained supported
Buy 1.5x EFA Jun17 103% call, sell 1x EFA May17 ATM call	6-Mar-17	-0.15%	-0.20%	19-May-17	EFA rallied strongly leading into the second round of the French elections but subsequently stalled
Buy SPX Top50 volatility dispersion	27-Feb-16	14.7%	11.5%	30-May-17	Expired
Long HSI vs. SPX May-17 90% put switch	06-Feb-17	0.07%	0.00%	29-May-17	Option expired; Both HSI and SPX puts expire out-of-the-money
Buy the Nifty May17 95/105% strangle outright	20-Mar-17	1.20%	0.00%	25-May-17	Option expired; Nifty failed to move more than the straddle huddle (5%)
Long HSBC May-17 65/70 call spread	3-Apr-17	0.95%	4.33%	29-May-17	Option expired; HSBC is up 6.75% on the back of a strong seasonal rally
Buy NKY Jun17 110% Call	02-Dec-16	1.83%	0.00%	9-Jun-17	Closing the trade on expiry; Japan market rallied but options remain out of the money
Buy TPINSU Jun17 110-125% Call Spread	02-Dec-16	3.30%	0.00%	9-Jun-17	Closing the trade on expiry; Japan market rallied but options remain out of the money
Buy TPNBNK Jun17 110-125% Call Spread	02-Dec-16	3.20%	0.00%	9-Jun-17	Closing the trade on expiry; Japan market rallied but options remain out of the money
Buy NKY Jun17-Jun18 18,500 strike FVA	02-Dec-16	21.5%	19.1%	9-Jun-17	Closing the trade on Jun17 expiry; Global volatility collapsed in 1H2017
Buy an EWZ Jun-17 40 call conditional on SPX<2200 at expiry	24-Oct-16	1.70%	0%	19-Jun-17	Recent political turmoil in Brazil surrounding Temer's presidency caused a slide in the Brazilian equity market and the BRL
Buy SPX Jun17 95% put contingent on US 5Y CMS > 2.15	5-Dec-16	1.04%	0%	19-Jun-17	In Dec-16, we recommended remaining long equities overlayed with cheap hedges. The hedge expires out of the money, while SPX has returned 10.2% for the period
Buy 1x Jun-17 ATM XLF call, sell 1.8x Jun-17 ATM worst-of calls on XLP and XLU	5-Dec-16	2.10%	-12.90%	19-Jun-17	Following the US election and the initial move in rates, XLF rallied and subsequently stalled. In the same period, the defensive sectors played the catch-up trade
Buy Jun-17 ATM R2K- value outperf call over EEM, contingent on EEM >95%	5-Dec-16	2.30%	0%	19-Jun-17	Concerns over US tax reform implementation caused small-caps to underperform relative to other equity markets, including EM
Buy QQQ Jun17 132 call , sell XLF Jun17 25 call	20-Mar-17	0.57%	4.73%	19-Jun-17	The trade captured the recent Tech sector outperformance in a period when Financials lagged driven by lower rates

Source: BofA Merrill Lynch Global Research. Prices reflective of most recently available data which may be delayed in some cases. "Trade Value" represents current valuation of trades initiated on the "Open Date".

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Volatility in Numbers (16-Jun-17)

Table 11: Statistics on implied, realised, skew and term structure for 3-month and 12-month vols (developed markets)

	3-month							12-month						
	S&P500	ESTX50	FTSE	DAX	NKY	HSI	KOSPI	S&P500	ESTX50	FTSE	DAX	NKY	HSI	KOSPI
Implied	9.8%	13.4%	10.0%	12.6%	13.8%	12.4%	12.2%	14.0%	16.8%	13.6%	16.6%	17.2%	15.8%	14.6%
%tile (2yr)	1.2%	1.6%	0.6%	0.8%	0.4%	4.1%	19.9%	7.7%	5.6%	9.5%	5.5%	1.8%	6.3%	24.9%
1Week Change	-0.2%	0.3%	-0.4%	0.3%	-0.2%	0.1%	0.3%	0.1%	0.1%	-0.1%	0.1%	-0.4%	0.0%	0.1%
1Mth Change	-0.2%	0.0%	0.0%	-0.4%	-0.5%	-0.3%	-0.2%	0.1%	0.3%	0.6%	0.1%	0.2%	0.2%	0.7%
Realised	7.0%	11.4%	9.6%	10.7%	12.2%	10.2%	10.7%	9.5%	13.3%	12.2%	15.1%	19.6%	13.5%	11.4%
%tile (2yr)	11.5%	15.5%	15.6%	9.4%	0.6%	0.8%	21.1%	0.0%	0.0%	0.0%	0.0%	10.8%	1.4%	20.7%
1Week Change	-0.2%	0.2%	0.2%	0.4%	-0.3%	0.1%	-0.1%	-0.1%	-3.2%	-0.3%	-0.4%	-0.2%	0.1%	-0.1%
1Mth Change	0.4%	-0.1%	0.1%	0.1%	-0.2%	-0.5%	0.1%	0.0%	-3.8%	-0.7%	-1.0%	-0.4%	-0.5%	0.0%
Imp-real spread	2.7%	2.0%	0.4%	1.9%	1.6%	2.3%	1.5%	4.5%	3.5%	1.4%	1.5%	-2.3%	2.3%	3.1%
Spread %tile (2yr)	57.9%	55.7%	45.1%	57.2%	67.8%	71.3%	58.6%	91.5%	100.0%	85.2%	99.2%	61.6%	89.2%	70.8%
1Week Change	-0.1%	0.1%	-0.5%	-0.2%	0.0%	0.1%	0.4%	0.1%	3.3%	0.2%	0.4%	-0.2%	-0.1%	0.2%
1Mth Change	-0.6%	0.1%	-0.1%	-0.5%	-0.2%	0.2%	-0.2%	0.2%	4.1%	1.3%	1.2%	0.6%	0.7%	0.7%
90-110 skew	8.5%	8.4%	6.2%	8.5%	5.8%	3.3%	3.8%							
%tile (2yr)	16.1%	71.8%	8.8%	66.7%	47.9%	17.8%	14.2%							
1Week Change	0.2%	0.9%	0.2%	0.7%	0.0%	0.9%	0.8%							
1Mth Change	0.5%	2.4%	1.2%	1.6%	0.2%	0.9%	0.9%							
	10-day realised							**12M - 3M term vol spread**						
	S&P500	ESTX50	FTSE	DAX	NKY	HSI	KOSPI	S&P500	ESTX50	FTSE	DAX	NKY	HSI	KOSPI
Current Level	3.2%	9.4%	8.3%	12.1%	7.1%	9.9%	10.6%	4.3%	3.4%	3.6%	3.9%	3.5%	3.4%	2.4%
%tile (2yr)	1.0%	16.3%	21.7%	26.3%	0.8%	15.5%	46.7%	99.8%	98.9%	99.6%	99.6%	98.9%	96.9%	79.5%
1Week Change	-1.5%	2.1%	1.2%	2.5%	-4.1%	4.6%	0.9%	0.3%	-0.2%	0.2%	-0.2%	-0.2%	-0.1%	-0.2%
1Mth Change	-0.4%	0.9%	0.4%	5.2%	-5.8%	0.1%	-6.2%	0.3%	0.3%	0.6%	0.5%	0.7%	0.4%	0.9%
	Cash index													
Current Level	2,433.15	3,543.88	7,463.54	12,752.73	19,943.26	25,626.49	306.79							
1Wk Change	0.06%	-1.18%	-0.85%	-0.49%	-0.35%	-1.55%	-0.84%							
1Mth Change	1.35%	-2.69%	-0.78%	-0.40%	0.12%	1.15%	2.38%							

Source: BofA Merrill Lynch Global Research

Table 12: Statistics on implied, realised, skew and term structure for 3-month and 12-month vols (emerging markets)

	3-month				12-month			
	EEM US	IBOV	RDXUSD	TOP40	EEM US	IBOV	RDXUSD	TOP40
Implied	15.6%	22.9%	25.9%	16.9%	19.2%	24.3%	26.7%	18.5%
%tile (2yr)	5.0%	31.7%	28.7%	15.6%	8.9%	39.2%	26.7%	9.2%
1Wk Change	0.5%	-1.7%	0.9%	1.2%	0.2%	-0.2%	0.5%	0.8%
1Mth Change	0.5%	1.8%	2.6%	1.9%	1.4%	2.0%	1.4%	0.5%
Realised	11.8%	25.3%	20.5%	11.0%	17.6%	22.5%	20.4%	14.9%
%tile (2yr)	0.2%	58.8%	20.8%	3.2%	8.5%	5.7%	0.0%	2.8%
1Wk Change	-1.2%	-0.6%	-1.1%	0.3%	-0.2%	-0.4%	-0.4%	0.1%
1Mth Change	-1.2%	6.6%	0.0%	-0.6%	-0.2%	1.5%	-0.9%	-0.2%
Imp-real spread	3.8%	-2.4%	5.4%	5.8%	1.6%	1.9%	6.3%	3.6%
Spread %tile (2yr)	85.5%	11.7%	71.7%	95.0%	65.5%	74.9%	99.0%	74.9%
1Wk Change	1.8%	-1.1%	2.0%	1.0%	0.5%	0.1%	1.0%	0.7%
1Mth Change	1.7%	-4.8%	2.7%	2.5%	1.6%	0.5%	2.3%	0.7%
90-110 skew	7.0%	5.9%	5.2%	8.0%				
%tile (2yr)	32.8%	68.4%	26.2%	35.4%				
1Wk Change	0.7%	0.8%	0.4%	0.4%				
1Mth Change	0.9%	0.4%	0.6%	1.3%				
	10-day realised				**12M - 3M term vol spread**			
	EEM US	IBOV	RDXUSD	TOP40	EEM US	IBOV	RDXUSD	TOP40
Current Level	8.1%	8.8%	17.0%	12.2%	3.6%	1.4%	0.9%	1.7%
%tile (2yr)	4.0%	0.2%	17.8%	26.3%	97.5%	80.5%	57.7%	46.2%
1Wk Change	-0.5%	-4.3%	-2.2%	0.8%	-0.3%	1.5%	-0.4%	-0.5%
1Mth Change	-3.9%	-8.1%	-2.7%	5.3%	1.0%	0.2%	-1.2%	-1.4%
	Cash index							
Current Level	41.22	61,626.41	1,136.99	44,512.15				
1Wk Change	-0.94%	-0.94%	-3.70%	-2.97%				
1Mth Change	-1.10%	-10.28%	-11.99%	-6.15%				

Source: BofA Merrill Lynch Global Research

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Options Risk Statement

Potential Risk at Expiry & Options Limited Duration Risk

Unlike owning or shorting a stock, employing any listed options strategy is by definition governed by a finite duration. The most severe risks associated with general options trading are total loss of capital invested and delivery/assignment risk, all of which can occur in a short period.

Investor suitability

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From: Weingarten, Reid [redacted]
Sent: 7/4/2017 4:46:06 PM
To: jeevacation@gmail.com
Subject: Fw: The new iterations of Ghislaine Maxwell

Importance: High

Sent from my BlackBerry 10 smartphone.

From: [redacted]
Sent: Saturday, July 1, 2017 12:49 PM
To: [redacted]
Cc: Ainbanklaw Info; [redacted] Denyse Sabagh; [redacted]; Michael Baxter; [redacted]; Patrick M. Regan; [redacted]; Robert Barnett; Weingarten, Reid; [redacted]; [redacted]; [redacted]; Ellen Kerns; [redacted]
Subject: Re: The new iterations of Ghislaine Maxwell

We know of course that Saturdays are reserved for Matthew Horton.

On Saturday, July 1, 2017, 12:06:29 PM EDT, [redacted] wrote:

Rich Beckler,
Ken Adams,

Do you remember when I'd asked you what your daughters did for a living? Especially last night Mr. Beckler, as most Friday nights, no?

Yes, they are the new iterations of Ghislaine Maxwell; for you Richard Beckler, this originated from my being a former Stone Ridge classmate of his elder daughter Katie Beckler, and because he was on the Board of Stone Ridge during this period in time when my every family, friend, acquaintance and association was being contacted, bribed in one form or another, and turned against me (see below); as for Ken Adams, it stemmed from my having contacted him for representation in my 2011-filed case against IBM also during this period of time when my every communication were being tracked.

You both are interesting; you let us see what's to become of the Scalia 35 (see below; at bottom, Ghislaine Maxwell's Jeffrey Epstein in context.)

*

We start from this following precept: (the repeating 9/11s)

1. "Toward a New World Order" speech by Pres. George H.W. Bush – 9/11 (1990)

2. WTC Attack – 9/11 (2001)

3. BENGHAZI Attack – 9/11 (2012)

But you have to remember that H. W. Bush was planted:

AUTHOR PETER DALE SCOTT: Sometimes you have little deep events that most people don't even notice. One of those would be the Halloween Massacre. The older people remember the Saturday Night Massacre which happened under Nixon. I'm talking about the Halloween Massacre of October 31, 1975, and probably people watching this show have never heard of it.

That was under Ford, and Ford may have condoned it because it was trying to help restore his popularity. He was going way down in the polls. But it was a very important series of events all on the same night. The head of the CIA was fired, William Colby, replaced by a relatively unknown man called George H. W. Bush who then went on to authorize something that Colby had refused to authorize - the Team B report - the Team B to recalculate the Soviet threat and it was pre-determined. They were going to find that it was much bigger than the professionals angled like Raymond [inaudible] that I mentioned.

They said Russia is less of a threat now than it used to be. Well, that was terrible news for the industrial complex so the Team B came in and said oh, no, no, no, it's much more of a threat than it used to be, and that's why we got this huge military build-up. It started actually under Carter but we think of it as the Reagan build-up, and that of course is a major factor in having ended the Soviet Union because the Soviet Union tried to match it with a weaker economy. And that arms race which was not about threats but was about fighting economic war, that was an arms race which you could say that the Soviet Union lost because they couldn't keep it up. Their economy went more and more downhill because they were deflecting resources away from vital domestic functions. But really I'm trying to talk here about the Halloween Massacre...

Just the change in the CIA was a major historical event but it wasn't very visible. The second thing that happened was they fired Jim Schlesinger as Secretary of Defense... It was being done by [President Ford's] Chief of Staff and his assistant who are two names barely known then but quite famous since. Chief of staff was Donald Rumsfeld and the assistant was Dick Cheney. And that was the first real intrusion of the Rumsfeld-Cheney team into American politics. And they became the real heart of what I consider the Deep State in the 1980s when they were planning for Continuity of Government which was a plan for emergency rules like warrantless surveillance and warrantless detention and the militarization of homeland security. All those things were planned all through the '80s - COG planning by Donald Rumsfeld and Dick Cheney. Even when Rumsfeld wasn't in the government, he was authorized by Reagan to do this planning.

And why is that important to our history? Because in 2001, these two men were now in the government - Vice President and Secretary of Defense - the two top people in Washington on September the 11th, 2001 when Bush was down in Florida - George W. Bush - and what did they do on that day? They implemented the plans they had been planning for 20 years. Another major event in American history but it's not usually told that way.

We implemented - it's in the 9/11 Commission Report that COG plans were implemented on that day. This is a huge change in our country. We now have an ARMY command, NORTHCOM, to take charge of America - North America, the way SOUTHCOM is in charge of South America and CENTCOM is in charge of Central Asia.

This used to be illegal... We had the posse comitatus acts which said, yes, if there's a real emergency

you could call up the ARMY to deal with the emergency, but you cannot do it on a permanent basis but we now do do it on a permanent basis. We haven't even bothered to repeal the posse comitatus. We are in a state of emergency that was declared on September the 14th, 2001. And it's still enforced. It has to be renewed every year. Obama did it every year just as George Bush renewed it every year.

What are the roots of this? Well there are the legitimate roots that go back to fear of an atomic decapitation of the government back in the Truman era, so legitimate COG planning goes back to Truman and Eisenhower, but the illegitimate use of COG to deal with any emergnecy you like, that goes to the Reagan administration and it really goes back to the [Halloween] Massacre where Rumsfeld and Cheney put their thumbprint on American politics for the first time.

-- interview of Peter Dale Scott, @ min. 32:00,
https://www.youtube.com/watch?v=hNqDAYWYFuQ&t=2433s

This all suggests that the start of the 9/11 agenda pre-dated him as well. I see now that there was a seemingly relevant 1990 event as well. "On September 11, 1970 -- a date that only took on haunting overtones with the attacks on New York and Washington in 2001 -- Nixon became the first U.S. president to try to protect air travelers from extremists who sensed gaping vulnerabilities in security for commercial airliners, issuing a statement listing a string of measures including the introduction of 100 air marshals on U.S. planes. "Most countries, including the United States, found effective means of dealing with piracy on the high seas a century and a half ago," Nixon said. "We can -- and we will -- deal effectively with piracy in the skies today."
The President had been jolted into action by the simultaneous hijackings of planes in Europe headed to the United States. Jets belonging to TWA, Pan Am and Swissair were seized by the Popular Front for the Liberation of Palestine. The group also attempted to hijack a jet over London belonging to the Israeli airline El Al but was thwarted by security guards on board.
The Pan Am seizure ended quickly, but the passengers on the TWA and Swissair jets were diverted to a British air base in Jordan and the drama only ended after days of tense diplomacy, when the hostages were all released in a deal in which the Swiss, German, British and Israeli governments let Palestinian prisoners go." (http://www.cnn.com/2015/07/27/politics/terrorism-1970s-richard-nixon/index.html)

This 9/11 response sounds quite normal of course. But fast forward and the two secret service individuals chosen for an April 2001 interview by a PWC staff member on behalf of what becomthe IBM Center for the Business of Government were (1) Steve Colo who happened to be the head of the division at SAIC that falsely labeled me a threat and added my name to some sort of Do Not Admit list at the end of a 5 month temp assignment in 2005 into early 2006. The consequence of the SAIC designation for me was the following:

(I write) "The SAIC designation took advantage of a devilish stratagem in which as a national security employee (having filed out a SF-86 form, governed actually by the GSA - https://www.gsa.gov/portal/forms/download/116390 - for government clearance) working a designated contract in a classified facility, being designated a disturbance/dissident/threat to operations, makes one, in turn, a threat to national security - with all the surveillance/targeting that enables." In essence I was made an enemy of the State and was tracked, my family and friends turned, my opportunities seized to include the opportunity to rear family as demonstrated especially in the 2007 sabotage of my third trimester pregnancy and then the targeting and eventual capture of children I used to babysit - in 2011, they were predominantly tweens - to be used for sexual blackmail and other forms of leverage. The reason for the use of children in this barbaric way was to expend "ops" that were already in effect and had been used to control many of the politicians that have been allowed to rise to the top (see info on the Franklin Scandal for example), and similarly according to the laws of

compromise, the following which has been recently developing into highly coordinated murder "ops":

(I write) "The progress that was made from the absorbing of my (small) network (and this through sources and methods - money and other pleasureful compensations given to those willing to participate in and/or coordinate violence against me and my loved ones to include children leading only to now their enabled targeting and the absorbing of whatever may be their networks - well, you see below (and this only the very tip of the iceberg) how many people they've been able to engulf and what advances have been made by the quite elaborate criminal class employing these tactics; and one also begins to better understand the events surrounding Justice Scalia's passing and what's to come for the 35 guests in Scalia's private party. As for Scalia's passing, it was decidedly suspicious as noted by William Ritchie: (The Washington Post prints) "As a former homicide commander, I am stunned that no autopsy was ordered for Justice Scalia," William O. Ritchie, former head of criminal investigations for D.C. police, wrote in a post on Facebook on Sunday... Ritchie also raised questions about the marshals' actions: "How can the Marshal say, without a thorough post mortem, that he was not injected with an illegal substance that would simulate a heart attack… Did the US Marshal check for petechial hemorrhage in his eyes or under his lips that would have suggested suffocation? Did the US Marshal smell his breath for any unusual odor that might suggest poisoning? My gut tells me there is something fishy going on in Texas."

As for SAIC, the following also pertains:

(I write) "If you first see SAIC as what's called a systems integrator (author Tim Shorrock's phrase), and also the formerly married Bud and Sue Horton and their two grown sons Matthew Horton and Ben Lanier as aids of an implementation, you can better see the bigger picture:

(1) Sue Horton left IBM in early 2007-ish for an executive position at Tetra Tech which soon entered into joint venture with SAIC (Sue's employer prior to IBM, btw) on an enormous (billion dollar) 2011 Hillary Clinton State Department award (http://www.prnewswire.com/…/saic-tetra-tech-joint-venture-a…);

(2) that Bud Horton left IBM in early 2009-ish for an executive position at Accenture which soon thereafter entered into joint venture with SAIC spin-off Leidos, and Cerner, on an enormous (billion dollar) 2015 DoD award (http://www.healthcareitnews.com/…/dod-names-ehr-contract-wi…);

(3) that the Sue Horton contract was used to grow and fortify the Afghan heroin trade (as well as corrupt law enforcement) although the stated intention was of course the opposite... ("[SAIC and Tetra Tech's] joint venture, Integrated Justice Systems International, LLC (IJSI), has been awarded a contract to provide worldwide civilian police and criminal justice assistance to the U.S. Department of State's Bureau of International Narcotics and Law Enforcement Affairs (INL)... [specifically} to provide INL with program management, criminal justice, and life and mission support to countries emerging from conflict or otherwise facing instability challenges. Under this new contract, IJSI will provide technical assistance, training, logistics and infrastructure services to support the Department of State's efforts to strengthen criminal justice systems in select partner countries.")... yet, just months shy of contract end, the NY Times reported: "Tasked With Combating Opium, Afghan Officials Profit From It;" "Penetrating Every Stage of Afghan Opium Chain, Taliban become a Cartel;" and "Corrupt Combatants Fight for Control of Lucrative Afghan Drug Trade;" see also here an overview of the growth of Afghan opium production from the start of the US occupation (2001) to the present, and especially from contract start (2011) to end (2016): http://www.globalresearch.ca/the-spoils-of-war-afghanist…/91;

(4) and that the award Bud Horton helped secure just as Sue's contract was coming to an end was not only born from what looks like Franklin Scandal compromises, but it is this contract that seems

intent on implementing bioterrorism as the new form of explosive terrorism."

(Note that both members of this family were awarded BILLION dollar contracts; that's quite exceptional, no?)

As for terrorism as an US industry, it's hardly better seen than through the following which is information of course we all know:

We note that in-between Bush #41's 9/11/1990 speech(with Dick Cheney as his Secretary of Defense) and the 9/11/2001 attack on the WTC were little more than Clinton's 8 years in the White House. We look also to The American Deep State by Peter Dale Scott for evidence of ties between the actions of the Clinton administration and (1) the 1993 attack on the WTC and (2) the 1998 attack on the US embassy in Nairobi, Kenya which demonstrate that the Clinton administration in no uncertain terms sponsored terrorism:

(Writes Scott) "The homicidal crime suggested by Fenton's meticulous research is one both difficult and painful to contemplate. It has to be considered in the light of the earlier instances of protection we have surveyed:

1. the protection given to Salameh and Abouhalima in the 1990 Kahane murder, leaving them free to participate in the 1993 World Trade Center bombing;

2. the failure for two or three years to process Ali Mohamed's documents seized in 1990, which could have prevented the 1993 World Trade Center bombing;

3. the release of Ali Mohamed from Royal Canadian Mounted Police detention in 1993, leaving him free to participate in the 1998 Nairobi Embassy bombing;

4. the treatment of Ali Mohamed as an "unindicted coconspirator" in the 1993 WTC bombing case and Landmarks case, leaving him free to participate in the 1998 Nairobi Embassy bombing.

(pp. 76-77, The American Deep State)

Scott had earlier examined these attacks in especial connection to the September 11, 2001 attack on the WTC:

(Writes Scott) "For indeed it is certain that on various occasions U.S. agencies have intervened, letting al-Qaeda terrorists proceed with their plots. This alarming statement will be dismissed by some as "conspiracy theory." Yet in this chapter, I will show that this claim doesn't to arise from theory, but from facts that are true, even though they have been systemically suppressed or under-reported in the American mainstream media. I am describing a phenomenon that occurred not just once, but repeatedly, almost predictably. We shall see that, among the al-Qaeda terrorists who were first protected and then continued their activities were the following:

1. Ali Mohamed, identified in the 9/11 Commission Report as the leader of the 1998 Nairobi Embassy bombing;

2. Mohammed Jamal Khalife, Osama bin Laden's close friend and, while in the Philippines, financier of both Ramzi Yousef (principal architect of the first World Trade Center [WTC] attack) and his uncle Khalid Sheikh Mohammed;

3. Khalid Sheikh Mohammed, identified in the 9/11 Commission Report as "the principal architect of

the 9/11 attacks";

4. Khalid al-Mihdhar and Nawaf al-Hazmi, two of the alleged 9/11 hijackers, whose presence in the United States was concealed from the FBI by CIA officers for months before 9/11.

It might sound from these citations that the 9/11 Commission marked a new stage in the U.S. treatment of these terrorists, and that the report now exposed those terrorists who in the past had been protected. On the contrary, a principal purpose of my chapter is to show that

1. one purpose of protecting these individuals had been to protect a valued intelligence connection (the "al-Qaeda connection," if you will);
2. one major intention of the 9/11 Commission Report was to continue protecting this connection;
3. those on the 9/11 Commission staff who were charged with this protection included at least one commission member (Jamie Gorelick), one staff member (Dietrich Snell), and one important witness (Patrick Fitzgerald) who earlier had figured among the terrorists' protectors.

In the course of writing this chapter [Scott continues], I came to another disturbing conclusion I had not anticipated. This is that a central feature of the protection has been to defend the 9/11 Commission's false picture of al-Qaeda as an example of non-state terrorism, ignoring not just the CIA but also the royal families of Saudi Arabia and Qatar. In reality, as I shall show, royal family protection from Qatar and Saudi Arabia (concealed by the 9/11 Commission) was repeatedly given to key figures like Khalid Sheikh Mohammed, the alleged "principal architect of the 9/11 attacks." The establishment claims that the wars fought by America in Asia since 9/11 have been part of a global "war on terror." But this "war on terror" has been fought in alliance with Saudi Arabia, Qatar, and Pakistan - precisely the principal political and financial backers of the al-Qaedist networks the United States has supposedly been fighting. Meanwhile the most authentic opponents in the region of these Sunni al-Qaedists - the governments of Iraq, Libya, Syria, and Iran - have found themselves overthrown (in the case of Iraq and Libya), subverted with U.S. support (in the case of Syria), or sanctioned and threatened as part of an "axis of evil" (in the case of Iran). We should not forget that, just one day after 9/11, "Rumsfeld was talking about broadening the objectives of our response and 'getting Iraq.'"

(pp. 44-45, The American Deep State)

Clinton's daughter is now poised to work global health initiatives which I would suggest is little more than a cover for on-going terrorism "ops".

To return to Steve Colo - in the interview he speaks of a partnership between the Secret Service, the FBI, and South Carolina's SLED (State Law Enforcement Division) to open a Computer Crime Center. Bud Horton (mentioned above) (long-affiliated with IT Security; his title at Accenture was Chief technology officer of it's cyber security practice) happened to have just moved to South Carolina from Loudoun County after being implicated in a continuing child sex scandal (see details below). Further, cyber-crime just so happens to be another of the arenas in which our Intelligence Community coordinates with the Russians: "The US cooperates with the FSB and Russia's interior ministry on counter-terrorism, organized crime, bio-terrorism, and cyber-crime." -- p. 243, Expelled: A Journalist's Descent into the Russian Mafia State, by Luke Harding) Most would interpret this quote to suggest that the nations work together to prevent these various threats. The reality is more the opposite; trust me when I say that the US doesn't work "ops" alone - the 2005 London Bombings is one notable example of a instance in which the US coordinated with also British intelligence in the perpetration of an attack.) I just tweeted this morning actually the following in regards to US coordinations with the Russians: "One must know a renowned Rus mafiaso was granted entry https://en.wikipedia.org/wiki/Vyacheslav_Ivankov#Moving_to_the_United_States … be4 the real story

of today's US-Rus relations is slowly known" in response to the following comment @turndeaux: Peter Dale Scott, who writes about the Deep State, says Russia issue is "a bona fide security issue, not a diversion".

About Bud Horton and the Loudoun County matter - in attempts to make a long story short, the following email chain:

On Monday, June 26, 2017 10:57 AM, [redacted] wrote:

Sheriff Chapman,
Loudoun Count, VA

Did you ever consider that Loudoun was a target? That your community was induced to walk it's own children down the plank as compensation for what Loudoun had done to the young Dima Yakovlev? Because now child exploitation is deeply embedded within your community with your own people (your own police, your own prosecutors, your own public defenders and private attorneys) protecting this very system that will be used to take the futures of your Loudoun children (see more of the details below). Is it possible that that's how this happened, and you saw it not unfolding before your eyes? Or was it simply money and just another good enough justification?

Forwarded Message

On Monday, June 26, 2017 10:24 AM, [redacted] wrote:

Changeis,

You reported in May of 2014 that you hired Bob Richel formerly of the DEA as Vice President of Corporate Development. In an April 2014 interview by the Loudoun County Police (those in the mouth of the lion but not quite aware of it yet but to have foreseen the ways in which the 2008 death of the Russian born 21 month-old Dima Yakovlev (renamed Chase Harrison by his Purcellville, VA adoptive parents) would have been used as "justification" for a (quite profitable) counter-offensive...) of Henry "Bud" Horton (characterized by Loudoun County as a "victim" of the recent "False statement to Law Enforcement Officer (LEO)" of him sexually exploiting the 15 year-old Anjulee Gunther), Henry "Bud" Horton named Bob Rachel as one of the DEA guys he used to work with. This takes on unusual significance in light of the below, no?

(How lovely, by the way, this following information and the ways in which it helps us understand many of the hidden influences: "Halliburton is also involved with the Russian mob. They're got sort of two things going on. One is oil and the other is drug trafficking. Halliburton is a story all by itself." (says Stan Goff, http://narconews.com/goffmccormick1.html))

On Saturday, June 24, 2017 2:43 PM, [redacted] wrote:

Mr. Satz,
State's Attorney, Broward County, Fl

I'm forwarding the below information as it pertains to Mrs. Lesley Simms and more importantly the ones with whom she continues to coordinate.

As you may know, she was once close with an individual named Matthew Horton with whom she attended George Mason University, and through Matthew, Ms. Simms became well-acquainted with

Matthew's parents Henry "Bud" Horton and Sue Popovich Horton who helped secure her a position at IBM upon her graduation from GMU. Both of these latter individuals (Bud and Sue Horton) were involved in the 2007 murder of my son, and they in collusion with their son Matthew continue in the exploitation of children Anjulee and Xian Gunther. The powers that be intend now for these children to (continue to) follow in the footsteps of Ms. Simms, and to that end, I would advise that you become acquainted with (1) the ways in which Ms. Simms subsidized her law school education and off course (2) her current and related endeavors especially as they relate to drug trafficking and terror financing (see below email to Mr. Martin of the St. Augustine Record).

On Friday, June 23, 2017 8:36 AM, [redacted] wrote:

Mr. Martin,
St. Augustine Record

Quite an interesting article about the litigation between Deputy Banks and Rusty Rogers (see: Deputy Banks' attorney claims FDLE agent's credibility 'destroyed') It must also be explored, of course, that Officers Rodgers was once well respected for his investigation and exposure of a terrorist financing network that permeated the sunny state of Florida - (the NY Times reports) "Agent Rodgers joined the state's elite investigative unit, the Florida Department of Law Enforcement, where he quickly earned agent-of-the-year honors — and a meeting with the governor — for helping dismantle a terrorist financing network that stretched from Florida to the Middle East" - and that terrorism is very much a well-protected U.S. industry (see below).

God forbid some poor should get away with disrupting the delicate state of secreted operations; as you yourself report, "As written in [Plaintiff Banks'] motion: "Defendant Rodgers' false, misleading and inconsistent testimony throughout the discovery process is so pervasive and extreme, and involves so many material issues, it has destroyed Defendant's credibility on all issues..." And here we see the "whole-of-government" attempts to restore balance.

*

As for the second Secret Service agent interviewed by the IBM Center for the Business of Government, his name is Dana Brown. He just so happened to have filled out his career with the Federal Air Marshall Service (October 2003-August 2008 as Director/Chief of Staff) followed by the TSA (March 2006-January 2009 as Asst. Administrator-Law Enforcement/Integrity Officer) states his LinkedIn profile. That he worked his way around to that which was largely put in place by the 1970 9/11 mini-event seems to me rather significant although I don't see all the details yet. I also don't yet see exactly who it was that birthed this lengthy 9/11 initiative we're suffering. It seems clear, however, that it was birthed prior to 1970.

The initiative has adjusted in some ways over time, but homage to 9/11 remains strong. Certain of the people deeply involved in these manipulations thought it was kismet that an individual well-suited to head the newly ordained Department of Homeland Security (that as we all know was the result of legislation rushed through Congress in the aftermath of the 9/11 (2001) attack) was born on the magical September 11th (this is Jeh Johnson); similarly, it is again being deemed a sign that the new Director of the National Science Foundation (NSF) (chosen and positioned as she was) is first-named France (last name Cordova) and that this name so perfectly relates to US intentions to use the NSF to forward "ops" that will solidify a US-France working relationship in the same way the 2005 London Bombings helped solidify the US-British working relationship. These France going-ons are in higher gear (I've noticed) since Macron was elected but it was prepped for long ago. I was working for IBM under IBM project manager Cathie Skoog at the NSF when my third trimester pregnancy was

sabotaged. The story of this sabotage and what followed is (briefly) this:

I've long-alleged that John and Avery Gunther (whose children I used to babysit) agreed to a quid pro quo exchange of financial compensation for help destroying my credibility on behalf of IBM against whom I'd filed a 2010 EEOC (Equal Employment Opportunity Commission) charge and a subsequent May 2011 civil suit.

Per the May 11, 2011 Complaint, McGuire v. John and Avery Gunther:

3. On April 6, 2011 Mr. and Mrs Gunther, with uncontrolled greed and total disregard for the rights and feelings of Ms. Nadine McGuire as well as those of their children, AFG and XWG, maliciously and with ill-intent, wrongfully completed and executed a Complaint and Motion for Preliminary Injunction requesting formal protection against Ms. Nadine McGuire.

4. Over the course of the previous few months, Mr. and Mrs. Gunther, colluding with persons against whom Ms. Nadine McGuire is currently furthering litigation, including but not limited to plaintiff's mother, Pauline Scala McGuire, and from whom they received and/or have been promised to receive monetary incentives, hid their relationships with said individuals, further lied about having those relationships in direct conversation with Ms. Nadine McGuire and Court testimony on May 4, 2011, and wrongfully completed and executed a Complaint and Motion for Preliminary Injunction against Ms. Nadine McGuire in cooperation and collaboration with said persons, resulting in the issuance of a Temporary Restraining Order against Ms. Nadine McGuire issued on April 6, 2011.

- Initial Complaint, 5/11/11, McGuire v. John and Avery Gunther, Case No.:2011 CA 003703 B, DC Superior Court, Judge Gregory Jackson presiding

In regards to the suit against IBM (McGuire v. IBM, 1:11CV528, US District Court of Virginia), the only suit in which Pauline Scala McGuire was listed as a defendant, the most important claim was one of “assault” that led to the 2007 death of my son. Per the filing:

Plaintiff, Grace Nadine McGuire, realleges the allegations of paragraphs 1-65 hereof as if fully set forth within and further alleges:

66. Defendant Palmisano's conduct in ascertaining the drug that was used on the plaintiff to end her pregnancy and take the life of her child on April 22, 2007, constitutes an intentional touching of the plaintiff by defendant Palmisano, and was undertaken deliberately and with actual malice towards the plaintiff and her unborn child.

67. Defendant Skoog, Susan Horton and Scala's conduct in coordinating the circumstances, creating physical proximity and the administering of the drug to the plaintiff that ended her pregnancy and took the life of her child on April 22, 2007 constituted an intentional touching of the plaintiff by said defendants, and was undertaken deliberately and with actual malice towards the plaintiff and her unborn child.

... 69. As the direct and proximate result of defendant Palmisano, Skoog, Susan Horton, and Scala's conduct, the plaintiff suffered a severe placental abruption, which terminated her pregnancy and ended the life of her unborn child, causing the plaintiff to suffer damages including but not limited to the loss of her child, loss of affection, grief, sorrow, extreme mental torment and emotional distress.

- Initial Complaint, filed 5/16/11, McGuire v. IBM, et al, Case No.: 1:11CV528, US District Court of Virginia - Eastern Division, Alexandria, Judge Leonie Brinkema presiding

This is to say that John and Avery Gunther helped IBM defend against an allegation of murder, and in this way they are accomplices to a cover-up. This is also to say that the characterization provided by John and Avery Gunther in their April 2011 Superior Court filing for a Protection Order against me and their admissions in this filing of having provided derogatory information to various persons and/or entities in the DC area to include school administrators, psychologists, and law enforcement, were more to harm me, especially in my chances to hold IBM accountable, than to protect either themselves or children Anjulee and Xian Gunther.

I also long-allege that the relationship that developed from this initial quid pro quo led to John and Avery Gunther being similarly compensated for what turned into the sexual exploitation of their two daughters. For more on child sexual exploitation for the sake of personal and professional leverage, see especially the following:

Nick Bryant | The Franklin Scandal & The Elite's Pedophilia Cover Up,
https://www.youtube.com/watch?v=68gvGGPjm0o&t=978s

That the NSF won't acknowledge the abuse, and won't respond even to my FOIA requests, and otherwise has gone to extents to protect Cathie Skoog and her co-conspirators at IBM and otherwise is all that was needed to have adequately turned the organization towards the interests of the Deep State. Now it is simply a matter of the Deep State continuing to put the NSF to use.

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Jeffrey Epstein in context:

(As sent to the Wash Post)

I send you this in response to the recent column entitled Believe in the Process by Kenneth Starr. Perhaps rethink any public affiliation with Ken Starr; although his demeanor on paper is undoubtably consoling, it is also a bit intoxifying when it would be best now if we keep our wits about us, no?

I say this from the following perspective - Ken Starr of the Starr Report, attorney for (1) Erik Prince of Blackwater and (2) convicted pedophile Jeffrey Epstein in context:

The Starr Report buried behind salacious detail of the Lewinsky affair almost nothing of Whitewater, Travelgate, or otherwise what many consider the murder of Vince Foster (Foster, albeit the subject of a different investigation was also under the purview of attorney Starr and formal investigation of the results of Starr's investigation were drowned out by the details of the Lewinsky affair.) This is a bit strange considering the Lewinsky affair was a moral failing and not an actionable criminal one as would have been the others had any proof surfaced.

Starr later defended Blackwater against wrongful deaths suit initiated by the families of the 2004 Fallujah Ambush victims - "In October 2006, Blackwater hired one of the nation's heaviest-hitting lawyers to represent it - Kenneth Starr, the independent counsel in the 1999 impeachment of President Bill Clinton over the Monica Lewinsky sex scandal... Starr and his colleagues argued that Blackwater was "constitutionally immune" from such lawsuits and said that if the Fallujah case were allowed to proceed, "Blackwater will suffer irreparable harm." In the eighteen-page petition to the Supreme Court, Blackwater argued that there are no other such lawsuits against private military/security companies in state courts "because the comprehensive regulatory scheme enacted by Congress and the President grant military contractors like Blackwater immunity from state-court litigation." (pp. 234-235, Blackwater). (Author Ken Davis writes) "The four men had spent the night

before they set off at marine base Camp Fallujah. But the men kept their distance from the leathernecks. Had they spoken to the marines, the Blackwater team might have learned that the Americans were already in the midst of a major offensive meant to assert control over the increasingly restive city, where elements of the radical Islamist movement and remnants of Saddam's army were beginning to aggressively strike back. at the American occupation" (p. 306, The Hidden History of American at War), and perhaps this is the only thing that makes sense of the fact that "Under the terms of its contract, Blackwater was supposed to supply these convoy security missions with two SUVs, each carrying three guards per vehicle; a driver, one man riding shotgun, and a third man in back with a heavy machine gun. Instead, the foursome set out that morning with just two men per car, each vehicle missing their rear gunner. The SUVs were only outfitted with a steel plate as extra armor. And the men had not been given maps." (p. 305).

Starr went on to defend Jeffrey Epstein abasing allegations of child sex trafficking - "Along with a dream team of attorneys that included Gerald Lefcourt, Roy Black, and Ken Starr, [Alan Dershowitz] was successful in getting federal investigators not to charge Epstein with moving his victims across state lines and other associated crimes. The federal non-prosecution agreement Epstein's legal team negotiated with the U.S. Attorney for the Southern District of Florida immunized all named and unnamed "potential co-conspirators" in Epstein's child trafficking network, which includes those who allegedly procured minors for Epstein and also any powerbrokers who may have molested them" (-http://gawker.com/flight-logs-put-clinton-dershowitz-on-ped…). Otherwise, Epstein's eventual 18 month sentence by the state of Florida was exceptionally light under the circumstances to include the number of victims who came forward with testimony. This is best understood in the context of children being used as a means to government-sponsored sexual blackmail and other forms of leverage.

See here Erik Prince in greater context: (the similarities between him and once (secretly) favored child Bin Laden)

The coordinations among global intelligence to make rather than eliminate terror as seen thru "assets" bin Laden (as M. Noriega before him) & Erik Prince:

About BL: "Some CIA officers will later say that [BL] serves as a semi-official liaison between the GIP [Saudi intel.] and warlords like Sayyaf."
(www.historycommons.org/entity.jsp?entity=ahmed_badeeb_1)

About EP: "Handcuffed by politics, the CIA had not been able to cultivate relationships with the key but messy leaders. Fortunately, Blackwater had no such political restrictions." (p. 54, Civilian Warriors by E. Prince)

We see also:

About BL: "Bin Laden established camps inside Khyber Pakhtunkhwa in Pakistan and trained volunteers from across the Muslim world to fight against the Soviet-backed regime, the Democratic Republic of Afghanistan" (Wikipedia)

About EP: "In his autobiography, he states that during the Yugoslav Wars in the early 1990s, he realized the need for private training facilities for special operations… Prince moved to Virginia Beach and personally financed the formation of Blackwater Worldwide in 1997. He bought 6,000 acres (24 km2) of the Great Dismal Swamp of North Carolina and set up a school for special operations" (Wikipedia)

Erik Prince is (becoming) no less an Amer. intelligence success story than bin Laden (in support of Terrorism as Geostrategy & a New World Order - see below). In short: (we note the repeating 9/11s, every 11 years): "Toward a NWO" speech by Bush #41 - Sept. 11 ('90); The WTC - Sept. 11 ('01); Benghazi - Sept. 11 ('12). (There is rhy. & reason also 2 the rise of ISIS.)

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About training camps:

I watched so to speak the creating of little torture pockets around the world as justified by Obama's desire to close Gitmo. The White House reports (2/23/16): "We'll continue to securely and responsibly transfer to other countries the 35 detainees already approved for transfer. This process involves extensive and careful coordination across our federal government to ensure that our national security interests are met when an individual is transferred to another country. We insist, for example, that foreign countries institute strong security measures." But are these not just the seeds of new training camps (growing concentrated and lauded violent temperaments) & was that not someone's exact intent?

In real-time (and as perpetrated on captured children):

3/19/14, sent to the now defunct FB page of D. Cheney:
Dick Cheney,

I wonder if it's possible that there is coordination with other countries concerning enhanced interrogation techniques, in the form of training perhaps?

Specifically, here in the United States, my sense is that there may be the use of vulnerable populations, with the intension to gain favor with and/or intimidate others, especially members of the international community.

*

And:

On Saturday, June 21, 2014 6:37 AM, [redacted] wrote:
To: [redacted]

Deputy Lyddy,

Her energy is very weak. She is physically exhausted, VERY sleep deprived, and HUNGRY.

[These were continuing experimentations in reversed-engineered SERE; the agreed upon techniques, taken from various regions of the world to be distributed to the various regions of the world, had to be deemed not torture and this is where organizations like the APA stepped in, then (during the Bush administration), and afterwards. See here for example: "And I think, you know, what's really important in the debate going forward among psychologists is the extent to which psychologists loaned their names and loaned their credentials and their Ph.D.s to this kind of activity and essentially were used by the Bush administration to provide a kind of "get out of jail free" card for the people who were, you know, doing these interrogations, because the logic, which I think Mark had mentioned, is, you know, this circular logic. So long as there are trained psychologists from the SERE program who are on site at these interrogations who are saying that these detainees can withstand this treatment, are not being harmed psychologically, then it's not torture. So, you know,

you've got this sort of [inaudible] tortured — tortured logic, which is the phrase that has come up, but it's this sort of self-justifying loop in which professionals are loaning their credentials to this kind of activity. And you see the same thing in the Office of Legal Counsel, where you have, you know, lawyers loaning their credentials to approving what are clear violations of the Geneva Conventions." (https://www.democracynow.org/2009/4/21/the_story_of_mitchell_jessen_associates)]

From: Weingarten, Reid [redacted]
Sent: 7/4/2017 5:57:07 PM
To: jeffrey E. [jeevacation@gmail.com]
Subject: Re: The new iterations of Ghislaine Maxwell

Importance: High

Too down...give me another day

Sent from my BlackBerry 10 smartphone.

From: jeffrey E.
Sent: Tuesday, July 4, 2017 12:53 PM
To: Weingarten, Reid
Subject: Re: Fw: The new iterations of Ghislaine Maxwell

On Tue, Jul 4, 2017 at 6:46 PM Weingarten, Reid [redacted] wrote:

Number?

Sent from my BlackBerry 10 smartphone.

From: [redacted]
Sent: Saturday, July 1, 2017 12:49 PM
To: [redacted]
Cc: Ainbanklaw Info; [redacted] Denyse Sabagh; [redacted]; Michael Baxter; [redacted]; Patrick M. Regan; [redacted]; Robert Barnett; Weingarten, Reid; [redacted]; Ellen Kerns; [redacted]
Subject: Re: The new iterations of Ghislaine Maxwell

We know of course that Saturdays are reserved for Matthew Horton.

On Saturday, July 1, 2017, 12:06:29 PM EDT, [redacted] wrote:

Rich Beckler,
Ken Adams,

Do you remember when I'd asked you what your daughters did for a living? Especially last night Mr. Beckler, as most Friday nights, no?

Yes, they are the new iterations of Ghislaine Maxwell; for you Richard Beckler, this originated from my being a former Stone Ridge classmate of his elder daughter Katie Beckler, and because he was on the Board of Stone Ridge during this period in time when my every family, friend, acquaintance and association was being contacted, bribed in one form or another, and turned against me (see below); as for Ken Adams, it stemmed from my having contacted him for representation in my 2011-filed case against IBM also during this period of time when my every communication were being tracked.

You both are interesting; you let us see what's to become of the Scalia 35 (see below; at bottom, Ghislaine Maxwell's Jeffrey Epstein in context.)

*

We start from this following precept: (the repeating 9/11s)

1. "Toward a New World Order" speech by Pres. George H.W. Bush – 9/11 (1990)

2. WTC Attack – 9/11 (2001)

3. BENGHAZI Attack – 9/11 (2012)

But you have to remember that H. W. Bush was planted:

AUTHOR PETER DALE SCOTT: Sometimes you have little deep events that most people don't even notice. One of those would be the Halloween Massacre. The older people remember the Saturday Night Massacre which happened under Nixon. I'm talking about the Halloween Massacre of October 31, 1975, and probably people watching this show have never heard of it.

That was under Ford, and Ford may have condoned it because it was trying to help restore his popularity. He was going way down in the polls. But it was a very important series of events all on the same night. The head of the CIA was fired, William Colby, replaced by a relatively unknown man called George H. W. Bush who then went on to authorize something that Colby had refused to authorize - the Team B report - the Team B to recalculate the Soviet threat and it was pre-determined. They were going to find that it was much bigger than the professionals angled like Raymond [inaudible] that I mentioned.

They said Russia is less of a threat now than it used to be. Well, that was terrible news for the industrial complex so the Team B came in and said oh, no, no, no, it's much more of a threat than it used to be, and that's why we got this huge military build-up. It started actually under Carter but we think of it as the Reagan build-up, and that of course is a major factor in having ended the Soviet Union because the Soviet Union tried to match it with a weaker economy. And that arms race which was not about threats but was about fighting economic war, that was an arms race which you could say that the Soviet Union lost because they couldn't keep it up. Their economy went more and more downhill because they were deflecting resources away from vital domestic functions. But really I'm trying to talk here about the Halloween Massacre...

Just the change in the CIA was a major historical event but it wasn't very visible. The second thing that happened was they fired Jim Schlesinger as Secretary of Defense... It was being done by [President Ford's] Chief of Staff and his assistant who are two names barely known then but quite famous since. Chief of staff was Donald Rumsfeld and the assistant was Dick Cheney. And that was the first real intrusion of the Rumsfeld-Cheney team into American politics. And they became the real heart of what I consider the Deep State in the 1980s when they were planning for Continuity of Government which was a plan for emergency rules like warrantless surveillance and warrantless detention and the militarization of homeland security. All those things were planned all through the '80s - COG planning by Donald Rumsfeld and Dick Cheney. Even when Rumsfeld wasn't in the government, he was authorized by Reagan to do this planning.

And why is that important to our history? Because in 2001, these two men were now in the government - Vice President and Secretary of Defense - the two top people in Washington on

September the 11th, 2001 when Bush was down in Florida - George W. Bush - and what did they do on that day? They implemented the plans they had been planning for 20 years. Another major event in American history but it's not usually told that way.

We implemented - it's in the 9/11 Commission Report that COG plans were implemented on that day. This is a huge change in our country. We now have an ARMY command, NORTHCOM, to take charge of America - North America, the way SOUTHCOM is in charge of South America and CENTCOM is in charge of Central Asia.

This used to be illegal... We had the posse comitatus acts which said, yes, if there's a real emergency you could call up the ARMY to deal with the emergency, but you cannot do it on a permanent basis but we now do do it on a permanent basis. We haven't even bothered to repeal the posse comitatus. We are in a state of emergency that was declared on September the 14th, 2001. And it's still enforced. It has to be renewed every year. Obama did it every year just as George Bush renewed it every year.

What are the roots of this? Well there are the legitimate roots that go back to fear of an atomic decapitation of the government back in the Truman era, so legitimate COG planning goes back to Truman and Eisenhower, but the illegitimate use of COG to deal with any emergnecy you like, that goes to the Reagan administration and it really goes back to the [Halloween] Massacre where Rumsfeld and Cheney put their thumbprint on American politics for the first time.

-- interview of Peter Dale Scott, @ min. 32:00,
https://www.youtube.com/watch?v=hNqDAYWYFuQ&t=2433s

This all suggests that the start of the 9/11 agenda pre-dated him as well. I see now that there was a seemingly relevant 1990 event as well. "On September 11, 1970 -- a date that only took on haunting overtones with the attacks on New York and Washington in 2001 -- Nixon became the first U.S. president to try to protect air travelers from extremists who sensed gaping vulnerabilities in security for commercial airliners, issuing a statement listing a string of measures including the introduction of 100 air marshals on U.S. planes. "Most countries, including the United States, found effective means of dealing with piracy on the high seas a century and a half ago," Nixon said. "We can -- and we will -- deal effectively with piracy in the skies today."
The President had been jolted into action by the simultaneous hijackings of planes in Europe headed to the United States. Jets belonging to TWA, Pan Am and Swissair were seized by the Popular Front for the Liberation of Palestine. The group also attempted to hijack a jet over London belonging to the Israeli airline El Al but was thwarted by security guards on board.
The Pan Am seizure ended quickly, but the passengers on the TWA and Swissair jets were diverted to a British air base in Jordan and the drama only ended after days of tense diplomacy, when the hostages were all released in a deal in which the Swiss, German, British and Israeli governments let Palestinian prisoners go." (http://www.cnn.com/2015/07/27/politics/terrorism-1970s-richard-nixon/index.html)

This 9/11 response sounds quite normal of course. But fast forward and the two secret service individuals chosen for an April 2001 interview by a PWC staff member on behalf of what becomthe IBM Center for the Business of Government were (1) Steve Colo who happened to be the head of the division at SAIC that falsely labeled me a threat and added my name to some sort of Do Not Admit list at the end of a 5 month temp assignment in 2005 into early 2006. The consequence of the SAIC designation for me was the following:

(I write) "The SAIC designation took advantage of a devilish stratagem in which as a national security employee (having filed out a SF-86 form, governed actually by the GSA -

https://www.gsa.gov/portal/forms/download/116390 - for government clearance) working a designated contract in a classified facility, being designated a disturbance/dissident/threat to operations, makes one, in turn, a threat to national security - with all the surveillance/targeting that enables." In essence I was made an enemy of the State and was tracked, my family and friends turned, my opportunities seized to include the opportunity to rear family as demonstrated especially in the 2007 sabotage of my third trimester pregnancy and then the targeting and eventual capture of children I used to babysit - in 2011, they were predominantly tweens - to be used for sexual blackmail and other forms of leverage. The reason for the use of children in this barbaric way was to expend "ops" that were already in effect and had been used to control many of the politicians that have been allowed to rise to the top (see info on the Franklin Scandal for example), and similarly according to the laws of compromise, the following which has been recently developing into highly coordinated murder "ops":

(I write) "The progress that was made from the absorbing of my (small) network (and this through sources and methods - money and other pleasureful compensations given to those willing to participate in and/or coordinate violence against me and my loved ones to include children leading only to now their enabled targeting and the absorbing of whatever may be their networks - well, you see below (and this only the very tip of the iceberg) how many people they've been able to engulf and what advances have been made by the quite elaborate criminal class employing these tactics; and one also begins to better understand the events surrounding Justice Scalia's passing and what's to come for the 35 guests in Scalia's private party. As for Scalia's passing, it was decidedly suspicious as noted by William Ritchie: (The Washington Post prints) “As a former homicide commander, I am stunned that no autopsy was ordered for Justice Scalia,” William O. Ritchie, former head of criminal investigations for D.C. police, wrote in a post on Facebook on Sunday... Ritchie also raised questions about the marshals’ actions: “How can the Marshal say, without a thorough post mortem, that he was not injected with an illegal substance that would simulate a heart attack… Did the US Marshal check for petechial hemorrhage in his eyes or under his lips that would have suggested suffocation? Did the US Marshal smell his breath for any unusual odor that might suggest poisoning? My gut tells me there is something fishy going on in Texas.”

As for SAIC, the following also pertains:

(I write) "If you first see SAIC as what's called a systems integrator (author Tim Shorrock's phrase), and also the formerly married Bud and Sue Horton and their two grown sons Matthew Horton and Ben Lanier as aids of an implementation, you can better see the bigger picture:

(1) Sue Horton left IBM in early 2007-ish for an executive position at Tetra Tech which soon entered into joint venture with SAIC (Sue's employer prior to IBM, btw) on an enormous (billion dollar) 2011 Hillary Clinton State Department award (http://www.prnewswire.com/…/saic-tetra-tech-joint-venture-a…);

(2) that Bud Horton left IBM in early 2009-ish for an executive position at Accenture which soon thereafter entered into joint venture with SAIC spin-off Leidos, and Cerner, on an enormous (billion dollar) 2015 DoD award (http://www.healthcareitnews.com/…/dod-names-ehr-contract-wi…);

(3) that the Sue Horton contract was used to grow and fortify the Afghan heroin trade (as well as corrupt law enforcement) although the stated intention was of course the opposite... ("[SAIC and Tetra Tech's] joint venture, Integrated Justice Systems International, LLC (IJSI), has been awarded a contract to provide worldwide civilian police and criminal justice assistance to the U.S. Department of State's Bureau of International Narcotics and Law Enforcement Affairs (INL)... [specifically} to provide INL with program management, criminal justice, and life and mission support to countries emerging from conflict or otherwise facing instability challenges. Under this new contract, IJSI will

provide technical assistance, training, logistics and infrastructure services to support the Department of State's efforts to strengthen criminal justice systems in select partner countries.")... yet, just months shy of contract end, the NY Times reported: "Tasked With Combating Opium, Afghan Officials Profit From It;" "Penetrating Every Stage of Afghan Opium Chain, Taliban become a Cartel;" and "Corrupt Combatants Fight for Control of Lucrative Afghan Drug Trade;" see also here an overview of the growth of Afghan opium production from the start of the US occupation (2001) to the present, and especially from contract start (2011) to end (2016): http://www.globalresearch.ca/the-spoils-of-war-afghanist…/91;

(4) and that the award Bud Horton helped secure just as Sue's contract was coming to an end was not only born from what looks like Franklin Scandal compromises, but it is this contract that seems intent on implementing bioterrorism as the new form of explosive terrorism."

(Note that both members of this family were awarded BILLION dollar contracts; that's quite exceptional, no?)

As for terrorism as an US industry, it's hardly better seen than through the following which is information of course we all know:

We note that in-between Bush #41's 9/11/1990 speech(with Dick Cheney as his Secretary of Defense) and the 9/11/2001 attack on the WTC were little more than Clinton's 8 years in the White House. We look also to The American Deep State by Peter Dale Scott for evidence of ties between the actions of the Clinton administration and (1) the 1993 attack on the WTC and (2) the 1998 attack on the US embassy in Nairobi, Kenya which demonstrate that the Clinton administration in no uncertain terms sponsored terrorism:

(Writes Scott) "The homicidal crime suggested by Fenton's meticulous research is one both difficult and painful to contemplate. It has to be considered in the light of the earlier instances of protection we have surveyed:

1. the protection given to Salameh and Abouhalima in the 1990 Kahane murder, leaving them free to participate in the 1993 World Trade Center bombing;

2. the failure for two or three years to process Ali Mohamed's documents seized in 1990, which could have prevented the 1993 World Trade Center bombing;

3. the release of Ali Mohamed from Royal Canadian Mounted Police detention in 1993, leaving him free to participate in the 1998 Nairobi Embassy bombing;

4. the treatment of Ali Mohamed as an "unindicted coconspirator" in the 1993 WTC bombing case and Landmarks case, leaving him free to participate in the 1998 Nairobi Embassy bombing.

(pp. 76-77, The American Deep State)

Scott had earlier examined these attacks in especial connection to the September 11, 2001 attack on the WTC:

(Writes Scott) "For indeed it is certain that on various occasions U.S. agencies have intervened, letting al-Qaeda terrorists proceed with their plots. This alarming statement will be dismissed by some as "conspiracy theory." Yet in this chapter, I will show that this claim doesn't to arise from theory, but from facts that are true, even though they have been systemically suppressed or under-reported in the American mainstream media. I am describing a phenomenon that occurred not just

once, but repeatedly, almost predictably. We shall see that, among the al-Qaeda terrorists who were first protected and then continued their activities were the following:

1. Ali Mohamed, identified in the 9/11 Commission Report as the leader of the 1998 Nairobi Embassy bombing;

2. Mohammed Jamal Khalife, Osama bin Laden's close friend and, while in the Philippines, financier of both Ramzi Yousef (principal architect of the first World Trade Center [WTC] attack) and his uncle Khalid Sheikh Mohammed;

3. Khalid Sheikh Mohammed, identified in the 9/11 Commission Report as "the principal architect of the 9/11 attacks";

4. Khalid al-Mihdhar and Nawaf al-Hazmi, two of the alleged 9/11 hijackers, whose presence in the United States was concealed from the FBI by CIA officers for months before 9/11.

It might sound from these citations that the 9/11 Commission marked a new stage in the U.S. treatment of these terrorists, and that the report now exposed those terrorists who in the past had been protected. On the contrary, a principal purpose of my chapter is to show that

1. one purpose of protecting these individuals had been to protect a valued intelligence connection (the "al-Qaeda connection," if you will);
2. one major intention of the 9/11 Commission Report was to continue protecting this connection;
3. those on the 9/11 Commission staff who were charged with this protection included at least one commission member (Jamie Gorelick), one staff member (Dietrich Snell), and one important witness (Patrick Fitzgerald) who earlier had figured among the terrorists' protectors.

In the course of writing this chapter [Scott continues], I came to another disturbing conclusion I had not anticipated. This is that a central feature of the protection has been to defend the 9/11 Commission's false picture of al-Qaeda as an example of non-state terrorism, ignoring not just the CIA but also the royal families of Saudi Arabia and Qatar. In reality, as I shall show, royal family protection from Qatar and Saudi Arabia (concealed by the 9/11 Commission) was repeatedly given to key figures like Khalid Sheikh Mohammed, the alleged "principal architect of the 9/11 attacks." The establishment claims that the wars fought by America in Asia since 9/11 have been part of a global "war on terror." But this "war on terror" has been fought in alliance with Saudi Arabia, Qatar, and Pakistan - precisely the principal political and financial backers of the al-Qaedist networks the United States has supposedly been fighting. Meanwhile the most authentic opponents in the region of these Sunni al-Qaedists - the governments of Iraq, Libya, Syria, and Iran - have found themselves overthrown (in the case of Iraq and Libya), subverted with U.S. support (in the case of Syria), or sanctioned and threatened as part of an "axis of evil" (in the case of Iran). We should not forget that, just one day after 9/11, "Rumsfeld was talking about broadening the objectives of our response and 'getting Iraq.'"

(pp. 44-45, The American Deep State)

Clinton's daughter is now poised to work global health initiatives which I would suggest is little more than a cover for on-going terrorism "ops".

To return to Steve Colo - in the interview he speaks of a partnership between the Secret Service, the FBI, and South Carolina's SLED (State Law Enforcement Division) to open a Computer Crime Center. Bud Horton (mentioned above) (long-affiliated with IT Security; his title at Accenture was Chief technology officer of it's cyber security practice) happened to have just moved to South

Carolina from Loudoun County after being implicated in a continuing child sex scandal (see details below). Further, cyber-crime just so happens to be another of the arenas in which our Intelligence Community coordinates with the Russians: "The US cooperates with the FSB and Russia's interior ministry on counter-terrorism, organized crime, bio-terrorism, and cyber-crime." -- p. 243, Expelled: A Journalist's Descent into the Russian Mafia State, by Luke Harding) Most would interpret this quote to suggest that the nations work together to prevent these various threats. The reality is more the opposite; trust me when I say that the US doesn't work "ops" alone - the 2005 London Bombings is one notable example of a instance in which the US coordinated with also British intelligence in the perpetration of an attack.) I just tweeted this morning actually the following in regards to US coordinations with the Russians: "One must know a renowned Rus mafiaso was granted entry https://en.wikipedia.org/wiki/Vyacheslav_Ivankov#Moving_to_the_United_States … be4 the real story of today's US-Rus relations is slowly known" in response to the following comment @turndeaux: Peter Dale Scott, who writes about the Deep State, says Russia issue is "a bona fide security issue, not a diversion".

About Bud Horton and the Loudoun County matter - in attempts to make a long story short, the following email chain:

On Monday, June 26, 2017 10:57 AM, [redacted] wrote:

Sheriff Chapman,
Loudoun Count, VA

Did you ever consider that Loudoun was a target? That your community was induced to walk it's own children down the plank as compensation for what Loudoun had done to the young Dima Yakovlev? Because now child exploitation is deeply embedded within your community with your own people (your own police, your own prosecutors, your own public defenders and private attorneys) protecting this very system that will be used to take the futures of your Loudoun children (see more of the details below). Is it possible that that's how this happened, and you saw it not unfolding before your eyes? Or was it simply money and just another good enough justification?

Forwarded Message

On Monday, June 26, 2017 10:24 AM, [redacted] wrote:

Changeis,

You reported in May of 2014 that you hired Bob Richel formerly of the DEA as Vice President of Corporate Development. In an April 2014 interview by the Loudoun County Police (those in the mouth of the lion but not quite aware of it yet but to have foreseen the ways in which the 2008 death of the Russian born 21 month-old Dima Yakovlev (renamed Chase Harrison by his Purcellville, VA adoptive parents) would have been used as "justification" for a (quite profitable) counter-offensive...) of Henry "Bud" Horton (characterized by Loudoun County as a "victim" of the recent "False statement to Law Enforcement Officer (LEO)" of him sexually exploiting the 15 year-old Anjulee Gunther), Henry "Bud" Horton named Bob Rachel as one of the DEA guys he used to work with. This takes on unusual significance in light of the below, no?

(How lovely, by the way, this following information and the ways in which it helps us understand many of the hidden influences: "Halliburton is also involved with the Russian mob. They're got sort of two things going on. One is oil and the other is drug trafficking. Halliburton is a story all by itself." (says Stan Goff, http://narconews.com/goffmccormick1.html))

On Saturday, June 24, 2017 2:43 PM, [redacted] wrote:

Mr. Satz,
State's Attorney, Broward County, Fl

I'm forwarding the below information as it pertains to Mrs. Lesley Simms and more importantly the ones with whom she continues to coordinate.

As you may know, she was once close with an individual named Matthew Horton with whom she attended George Mason University, and through Matthew, Ms. Simms became well-acquainted with Matthew's parents Henry "Bud" Horton and Sue Popovich Horton who helped secure her a position at IBM upon her graduation from GMU. Both of these latter individuals (Bud and Sue Horton) were involved in the 2007 murder of my son, and they in collusion with their son Matthew continue in the exploitation of children Anjulee and Xian Gunther. The powers that be intend now for these children to (continue to) follow in the footsteps of Ms. Simms, and to that end, I would advise that you become acquainted with (1) the ways in which Ms. Simms subsidized her law school education and off course (2) her current and related endeavors especially as they relate to drug trafficking and terror financing (see below email to Mr. Martin of the St. Augustine Record).

On Friday, June 23, 2017 8:36 AM, [redacted] wrote:

Mr. Martin,
St. Augustine Record

Quite an interesting article about the litigation between Deputy Banks and Rusty Rogers (see: Deputy Banks' attorney claims FDLE agent's credibility 'destroyed') It must also be explored, of course, that Officers Rodgers was once well respected for his investigation and exposure of a terrorist financing network that permeated the sunny state of Florida - (the NY Times reports) "Agent Rodgers joined the state's elite investigative unit, the Florida Department of Law Enforcement, where he quickly earned agent-of-the-year honors — and a meeting with the governor — for helping dismantle a terrorist financing network that stretched from Florida to the Middle East" - and that terrorism is very much a well-protected U.S. industry (see below).

God forbid some poor should get away with disrupting the delicate state of secreted operations; as you yourself report, "As written in [Plaintiff Banks'] motion: "Defendant Rodgers' false, misleading and inconsistent testimony throughout the discovery process is so pervasive and extreme, and involves so many material issues, it has destroyed Defendant's credibility on all issues..." And here we see the "whole-of-government" attempts to restore balance.

*

As for the second Secret Service agent interviewed by the IBM Center for the Business of Government, his name is Dana Brown. He just so happened to have filled out his career with the Federal Air Marshall Service (October 2003-August 2008 as Director/Chief of Staff) followed by the TSA (March 2006-January 2009 as Asst. Administrator-Law Enforcement/Integrity Officer) states his LinkedIn profile. That he worked his way around to that which was largely put in place by the 1970 9/11 mini-event seems to me rather significant although I don't see all the details yet. I also don't yet see exactly who it was that birthed this lengthy 9/11 initiative we're suffering. It seems clear, however, that it was birthed prior to 1970.

The initiative has adjusted in some ways over time, but homage to 9/11 remains strong. Certain of the people deeply involved in these manipulations thought it was kismet that an individual well-suited to head the newly ordained Department of Homeland Security (that as we all know was the result of legislation rushed through Congress in the aftermath of the 9/11 (2001) attack) was born on the magical September 11th (this is Jeh Johnson); similarly, it is again being deemed a sign that the new Director of the National Science Foundation (NSF) (chosen and positioned as she was) is first-named France (last name Cordova) and that this name so perfectly relates to US intentions to use the NSF to forward "ops" that will solidify a US-France working relationship in the same way the 2005 London Bombings helped solidify the US-British working relationship. These France going-ons are in higher gear (I've noticed) since Macron was elected but it was prepped for long ago. I was working for IBM under IBM project manager Cathie Skoog at the NSF when my third trimester pregnancy was sabotaged. The story of this sabotage and what followed is (briefly) this:

I've long-alleged that John and Avery Gunther (whose children I used to babysit) agreed to a quid pro quo exchange of financial compensation for help destroying my credibility on behalf of IBM against whom I'd filed a 2010 EEOC (Equal Employment Opportunity Commission) charge and a subsequent May 2011 civil suit.

Per the May 11, 2011 Complaint, McGuire v. John and Avery Gunther:

3. On April 6, 2011 Mr. and Mrs Gunther, with uncontrolled greed and total disregard for the rights and feelings of Ms. Nadine McGuire as well as those of their children, AFG and XWG, maliciously and with ill-intent, wrongfully completed and executed a Complaint and Motion for Preliminary Injunction requesting formal protection against Ms. Nadine McGuire.

4. Over the course of the previous few months, Mr. and Mrs. Gunther, colluding with persons against whom Ms. Nadine McGuire is currently furthering litigation, including but not limited to plaintiff's mother, Pauline Scala McGuire, and from whom they received and/or have been promised to receive monetary incentives, hid their relationships with said individuals, further lied about having those relationships in direct conversation with Ms. Nadine McGuire and Court testimony on May 4, 2011, and wrongfully completed and executed a Complaint and Motion for Preliminary Injunction against Ms. Nadine McGuire in cooperation and collaboration with said persons, resulting in the issuance of a Temporary Restraining Order against Ms. Nadine McGuire issued on April 6, 2011.

- Initial Complaint, 5/11/11, McGuire v. John and Avery Gunther, Case No.:2011 CA 003703 B, DC Superior Court, Judge Gregory Jackson presiding

In regards to the suit against IBM (McGuire v. IBM, 1:11CV528, US District Court of Virginia), the only suit in which Pauline Scala McGuire was listed as a defendant, the most important claim was one of “assault” that led to the 2007 death of my son. Per the filing:

Plaintiff, Grace Nadine McGuire, realleges the allegations of paragraphs 1-65 hereof as if fully set forth within and further alleges:

66. Defendant Palmisano's conduct in ascertaining the drug that was used on the plaintiff to end her pregnancy and take the life of her child on April 22, 2007, constitutes an intentional touching of the plaintiff by defendant Palmisano, and was undertaken deliberately and with actual malice towards the plaintiff and her unborn child.

67. Defendant Skoog, Susan Horton and Scala's conduct in coordinating the circumstances, creating physical proximity and the administering of the drug to the plaintiff that ended her pregnancy and took the life of her child on April 22, 2007 constituted an intentional touching of the plaintiff by said

defendants, and was undertaken deliberately and with actual malice towards the plaintiff and her unborn child.

... 69. As the direct and proximate result of defendant Palmisano, Skoog, Susan Horton, and Scala's conduct, the plaintiff suffered a severe placental abruption, which terminated her pregnancy and ended the life of her unborn child, causing the plaintiff to suffer damages including but not limited to the loss of her child, loss of affection, grief, sorrow, extreme mental torment and emotional distress.

- Initial Complaint, filed 5/16/11, McGuire v. IBM, et al, Case No.: 1:11CV528, US District Court of Virginia - Eastern Division, Alexandria, Judge Leonie Brinkema presiding

This is to say that John and Avery Gunther helped IBM defend against an allegation of murder, and in this way they are accomplices to a cover-up. This is also to say that the characterization provided by John and Avery Gunther in their April 2011 Superior Court filing for a Protection Order against me and their admissions in this filing of having provided derogatory information to various persons and/or entities in the DC area to include school administrators, psychologists, and law enforcement, were more to harm me, especially in my chances to hold IBM accountable, than to protect either themselves or children Anjulee and Xian Gunther.

I also long-allege that the relationship that developed from this initial quid pro quo led to John and Avery Gunther being similarly compensated for what turned into the sexual exploitation of their two daughters. For more on child sexual exploitation for the sake of personal and professional leverage, see especially the following:

Nick Bryant | The Franklin Scandal & The Elite's Pedophilia Cover Up,
https://www.youtube.com/watch?v=68gvGGPjm0o&t=978s

That the NSF won't acknowledge the abuse, and won't respond even to my FOIA requests, and otherwise has gone to extents to protect Cathie Skoog and her co-conspirators at IBM and otherwise is all that was needed to have adequately turned the organization towards the interests of the Deep State. Now it is simply a matter of the Deep State continuing to put the NSF to use.

*
*

Jeffrey Epstein in context:

(As sent to the Wash Post)

I send you this in response to the recent column entitled Believe in the Process by Kenneth Starr. Perhaps rethink any public affiliation with Ken Starr; although his demeanor on paper is undoubtably consoling, it is also a bit intoxifying when it would be best now if we keep our wits about us, no?

I say this from the following perspective - Ken Starr of the Starr Report, attorney for (1) Erik Prince of Blackwater and (2) convicted pedophile Jeffrey Epstein in context:

The Starr Report buried behind salacious detail of the Lewinsky affair almost nothing of Whitewater, Travelgate, or otherwise what many consider the murder of Vince Foster (Foster, albeit the subject of a different investigation was also under the purview of attorney Starr and formal investigation of the results of Starr's investigation were drowned out by the details of the Lewinsky affair.) This is a bit strange considering the Lewinsky affair was a moral failing and not an actionable criminal one as would have been the others had any proof surfaced.

Starr later defended Blackwater against wrongful deaths suit initiated by the families of the 2004 Fallujah Ambush victims - "In October 2006, Blackwater hired one of the nation's heaviest-hitting lawyers to represent it - Kenneth Starr, the independent counsel in the 1999 impeachment of President Bill Clinton over the Monica Lewinsky sex scandal... Starr and his colleagues argued that Blackwater was "constitutionally immune" from such lawsuits and said that if the Fallujah case were allowed to proceed, "Blackwater will suffer irreparable harm." In the eighteen-page petition to the Supreme Court, Blackwater argued that there are no other such lawsuits against private military/security companies in state courts "because the comprehensive regulatory scheme enacted by Congress and the President grant military contractors like Blackwater immunity from state-court litigation." (pp. 234-235, Blackwater). (Author Ken Davis writes) "The four men had spent the night before they set off at marine base Camp Fallujah. But the men kept their distance from the leathernecks. Had they spoken to the marines, the Blackwater team might have learned that the Americans were already in the midst of a major offensive meant to assert control over the increasingly restive city, where elements of the radical Islamist movement and remnants of Saddam's army were beginning to aggressively strike back. at the American occupation" (p. 306, The Hidden History of American at War), and perhaps this is the only thing that makes sense of the fact that "Under the terms of its contract, Blackwater was supposed to supply these convoy security missions with two SUVs, each carrying three guards per vehicle; a driver, one man riding shotgun, and a third man in back with a heavy machine gun. Instead, the foursome set out that morning with just two men per car, each vehicle missing their rear gunner. The SUVs were only outfitted with a steel plate as extra armor. And the men had not been given maps." (p. 305).

Starr went on to defend Jeffrey Epstein abasing allegations of child sex trafficking - "Along with a dream team of attorneys that included Gerald Lefcourt, Roy Black, and Ken Starr, [Alan Dershowitz] was successful in getting federal investigators not to charge Epstein with moving his victims across state lines and other associated crimes. The federal non-prosecution agreement Epstein's legal team negotiated with the U.S. Attorney for the Southern District of Florida immunized all named and unnamed "potential co-conspirators" in Epstein's child trafficking network, which includes those who allegedly procured minors for Epstein and also any powerbrokers who may have molested them" (-http://gawker.com/flight-logs-put-clinton-dershowitz-on-ped…). Otherwise, Epstein's eventual 18 month sentence by the state of Florida was exceptionally light under the circumstances to include the number of victims who came forward with testimony. This is best understood in the context of children being used as a means to government-sponsored sexual blackmail and other forms of leverage.

See here Erik Prince in greater context: (the similarities between him and once (secretly) favored child Bin Laden)

The coordinations among global intelligence to make rather than eliminate terror as seen thru "assets" bin Laden (as M. Noriega before him) & Erik Prince:

About BL: "Some CIA officers will later say that [BL] serves as a semi-official liaison between the GIP [Saudi intel.] and warlords like Sayyaf."
(www.historycommons.org/entity.jsp?entity=ahmed_badeeb_1)

About EP: "Handcuffed by politics, the CIA had not been able to cultivate relationships with the key but messy leaders. Fortunately, Blackwater had no such political restrictions." (p. 54, Civilian Warriors by E. Prince)

We see also:

About BL: "Bin Laden established camps inside Khyber Pakhtunkhwa in Pakistan and trained volunteers from across the Muslim world to fight against the Soviet-backed regime, the Democratic Republic of Afghanistan" (Wikipedia)

About EP: "In his autobiography, he states that during the Yugoslav Wars in the early 1990s, he realized the need for private training facilities for special operations... Prince moved to Virginia Beach and personally financed the formation of Blackwater Worldwide in 1997. He bought 6,000 acres (24 km2) of the Great Dismal Swamp of North Carolina and set up a school for special operations" (Wikipedia)

Erik Prince is (becoming) no less an Amer. intelligence success story than bin Laden (in support of Terrorism as Geostrategy & a New World Order - see below). In short: (we note the repeating 9/11s, every 11 years): "Toward a NWO" speech by Bush #41 - Sept. 11 ('90); The WTC - Sept. 11 ('01); Benghazi - Sept. 11 ('12). (There is rhy. & reason also 2 the rise of ISIS.)

***

About training camps:

I watched so to speak the creating of little torture pockets around the world as justified by Obama's desire to close Gitmo. The White House reports (2/23/16): "We'll continue to securely and responsibly transfer to other countries the 35 detainees already approved for transfer. This process involves extensive and careful coordination across our federal government to ensure that our national security interests are met when an individual is transferred to another country. We insist, for example, that foreign countries institute strong security measures." But are these not just the seeds of new training camps (growing concentrated and lauded violent temperaments) & was that not someone's exact intent?

In real-time (and as perpetrated on captured children):

3/19/14, sent to the now defunct FB page of D. Cheney:
Dick Cheney,

I wonder if it's possible that there is coordination with other countries concerning enhanced interrogation techniques, in the form of training perhaps?

Specifically, here in the United States, my sense is that there may be the use of vulnerable populations, with the intension to gain favor with and/or intimidate others, especially members of the international community.

*

And:

On Saturday, June 21, 2014 6:37 AM, [redacted] wrote:
To:[redacted]

Deputy Lyddy,

Her energy is very weak. She is physically exhausted, VERY sleep deprived, and HUNGRY.

[These were continuing experimentations in reversed-engineered SERE; the agreed upon techniques, taken from various regions of the world to be distributed to the various regions of the world, had to be deemed not torture and this is where organizations like the APA stepped in, then (during the Bush administration), and afterwards. See here for example: "And I think, you know, what's really important in the debate going forward among psychologists is the extent to which psychologists loaned their names and loaned their credentials and their Ph.D.s to this kind of activity and essentially were used by the Bush administration to provide a kind of "get out of jail free" card for the people who were, you know, doing these interrogations, because the logic, which I think Mark had mentioned, is, you know, this circular logic. So long as there are trained psychologists from the SERE program who are on site at these interrogations who are saying that these detainees can withstand this treatment, are not being harmed psychologically, then it's not torture. So, you know, you've got this sort of [inaudible] tortured — tortured logic, which is the phrase that has come up, but it's this sort of self-justifying loop in which professionals are loaning their credentials to this kind of activity. And you see the same thing in the Office of Legal Counsel, where you have, you know, lawyers loaning their credentials to approving what are clear violations of the Geneva Conventions." (https://www.democracynow.org/2009/4/21/the_story_of_mitchell_jessen_associates)]

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Fight to reopen teen sex case against Jeff Epstein may set precedent

LOCAL By Jane Musgrave - Palm Beach Post Staff Writer

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Jeffrey Epstein, the wealthy Palm Beach resident charged with having teenage girls give him sexual massages, pleaded guilty to prostitution solicitation charges in Palm Beach County Circuit Court on June 20, 2008. (Uma Sanghvi / The Palm Beach Post)

Posted: 8:00 a.m. Saturday, August 26, 2017

WEST PALM BEACH — Nearly 10 years after billionaire Jeffrey Epstein signed a plea deal that let him escape federal prosecution on charges of sexually abusing dozens of teenage girls at his Palm Beach mansion, the 64-year-old politically-connected money manager faces the possibility that the agreement could be thrown out.

In court papers filed this month, attorneys representing two of the 30 young women prosecutors say Epstein molested lodged their final written pleas aimed at spurring U.S. District Judge Kenneth Marra to force federal officials to reopen their investigation into the sordid case.

U.S. government lawyers in September will have another chance to defend themselves against allegations that they violated the federal Crime Victims' Rights Act by failing to alert Epstein's victims of the terms of what some describe as a "sweetheart deal." Marra could make a decision as early as this fall.

The stakes for all crime victims are high, said attorneys Bradley Edwards and Paul Cassell, who filed the rare lawsuit against the federal government on behalf of two Jane Does who were 13 and 14 when they claim Epstein paid them for sex.

If Marra dismisses the lawsuit, "then the government will never have to give *any* information in *any*

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case to *any* victim," they wrote, urging him to uphold the provisions of the 13-year-old federal law.

At the same time, the stakes are equally high for Epstein, who has ferried President Bill Clinton on his private jet and counts celebrities, such as Britain's Prince Andrew, as friends.

Marra has already ruled that if he finds that federal prosecutors violated the act, he will consider throwing out the plea deal that Epstein signed with federal prosecutors in 2007. Miami attorney Roy Black, one of dozens of high-profile lawyers who has represented Epstein, claims that would be manifestly unfair.

As part of the unusual non-prosecution agreement, which wasn't shared with victims for nearly a year while and after it was being negotiated, federal prosecutors agreed not to pursue charges that could have sent Epstein to prison for life. In exchange, Epstein in 2008 pleaded guilty in Palm Beach County Circuit Court to two Florida criminal charges — one count each of soliciting a minor for prostitution and soliciting prostitution. He served 13 months of an 18-month sentence in a vacant wing of the county stockade — a cell he was allowed to leave 16 hours a day, six days a week.

Epstein, who now spends most of his time on his private island in the U.S. Virgin Islands, also is required to register as a sex offender for the rest of his life. In addition, as part of the plea deal, he paid roughly 30 women, who were identified by prosecutors as his victims, undisclosed amounts of money to settle civil lawsuits they had filed against him.

To throw out the deal after Epstein has been punished would rob him of his constitutional right to due process, Black wrote in court papers. "If a defendant lives up to his end of the bargain, the government is bound to perform its promises," he wrote, quoting a prior court decision.

However, Edwards and Cassell claim that because federal prosecutors didn't confer with their clients about the plea deal before it was made, they violated the law and that makes the non-prosecution agreement illegal. They cited examples where plea deals have been invalidated after judges later found prosecutors violated the crime victims' rights law.

In most of the cases they cited, the mistakes were the result of oversights. But Edward and Cassell wrote, "The undisputed facts of this case prove that, rather than forthrightly discharging its obligations to numerous child sexual assault victims, the government chose to enter into a secret deal with the man who had victimized them."

Federal prosecutors have said they didn't reveal the terms of the non-prosecution agreement because they feared Epstein and his high-powered attorneys were trying to circumvent it. Still, Edwards and Cassell, said there was no justification for the secrecy.

"The government's conduct here was particularly egregious, because it repeatedly found time to confer with attorneys for Epstein — the man who sexually abused the victims," they said of emails and meetings between federal prosecutors, including U.S. Labor Secretary Alex Acosta, who was then U.S. attorney for South Florida.

In an affidavit, Edwards said Assistant U.S. Attorney Marie Villafana, who was handling Epstein's case, had numerous chances to tell him and the young women he represented about the non-prosecution agreement. Instead, four months after the agreement was signed in September 2007, federal officials wrote victims letters, assuring them the case was still under investigation.

"This can be a lengthy process and we request your continued patience while we conduct a thorough investigation," officials wrote in a January 2008 letter to Edwards' clients.

In court papers, Villafana said she alerted Edwards the day before Epstein was to plead guilty in circuit court, hoping that Edwards, his clients and other alleged victims would attend the hearing. But Edwards said neither he nor the young women had any idea that the plea in state court meant Epstein wouldn't be prosecuted for federal crimes.

"The victims (and their attorneys) could hardly have expected that the prosecutors and the man who had sexually abused them would be working together to conceal an arrangement that would prevent his prosecution for crimes against them," Edwards and Cassell wrote.

While Judge Marra could allow a jury to decide the complex case, prosecutors are asking him to toss the women's lawsuit and end the litigation.

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Edwards and Cassell instead want him to rule that prosecutors violated the Crime Victims' Rights Act. Once that determination is made, Marra could then decide what remedies to impose, the two lawyers argue.

Under the act, neither of their clients can seek "damages" from the government but the attorneys have suggested Marra could order the government to pay the women restitution, impose a monetary sanction and pay their legal fees.

Still, Cassell insisted: "This isn't about money, it's about justice."

Cassell, who is a law professor at the University of Utah, said the case is being watched closely by victims' rights advocates along with federal lawmakers who pushed the legislation through Congress and have publicly questioned prosecutors' handling of Epstein's case.

A decision ordering federal prosecutors to reopen the investigation could establish a national precedent, he said. "It will be a big win for the victims," Cassell said. "That's the way we look at it."

About the Author

JANE MUSGRAVE

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Next Up in Local

NEW: 3 things to know from Wellington council meeting Tuesday

by Kristina Webb, Palm Beach Post Staff Writer

Here are three things to know after Tuesday night's Wellington council meeting: 1. The village council held its final vote and approved the coming fiscal year's tax rate, 2.43, and $110 million budget. Though the tax rate is down from this year's 2.44, residents still will see a slight increase in their tax bills because property...

BREAKING: 27 years later, arrest in Wellington clown fatal shooting

by Hannah Winston, Palm Beach Post Staff Writer

For 27 years, investigators thought Sheila Keen had something to do with the clown who drove up to a

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Wellington home with flowers, balloons and a gun, and killed 40-year-old Marlene Warren. They believed Keen was having an affair with Michael Warren, Marlene's widow. They subpoenaed her then-husband and mother-in-law.The type of balloons found...

Jealous Florida woman stabs boyfriend at block party, police say

by Sandra Nortunen, Palm Beach Post Staff Writer

A 23-year-old Florida woman upset that her boyfriend was speaking to another woman at a party decided to stab him in the chest, news reports stated. Lashamera Yvette Smith and her boyfriend were out at a bar Friday night before they ended up at a block party during the wee hours of the following day, Volusia County Sheriff's Office investigators...

Boca board to buy golf course, re-brand it as 'Boca National Golf Club'

by Lulu Ramadan, Palm Beach Post Staff Writer

A Boca Raton taxing district has city support for buying a dilapidated golf course for $24 million, with plans to revitalize and re-brand it as "Boca National Golf Club." Talk of the Greater Boca Raton Beach and Park District — a taxing body independent of the city of Boca Raton — buying Ocean Breeze Golf Club, a 27-hole course...

Trump and fellow Palm Beacher, friend Robert Kraft at odds over anthem issue

by John Bisognano, Palm Beach Post Staff Writer

The next time President Donald Trump and fellow part-time Palm Beacher Robert Kraft, owner of the New England Patriots, share a meal at Trump's Winter White House, Mar-a-Lago, there may be some awkward moments. While the two have forged a close friendship over the years, and Kraft has donated $1 million dollars to Trump's inauguration...

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2. BREAKING: 27 years later, arrest made in fatal shooting by clown
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60 Years of Investigative Satire:
The Best of Paul Krassner

Introduction by Andy Borowitz

Blurb by Art Spiegelman

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What They Say About the Author

"Paul's own writing, in particular, seemed daring and adventurous to me; it took big chances and made important arguments in relentlessly funny ways. I felt, down deep, that maybe I had some of that in me, too; that maybe I could be using my skills to better express my beliefs. *The Realist* was the inspiration that kept pushing me to the next level; there was no way I could continue reading it and remain the same."

--George Carlin

"Paul Krassner--confidant of Lenny Bruce, co-founder of the Yippies, defiler of Disney characters, publisher of *The Realist*, and investigative satirist extraordinaire. As soon as we decided to create the *Huffington Post,* I knew I wanted him involved. His irreverence was just what the blog doctor ordered."

--Arianna Huffington

"Thanks to Paul Krassner for continuing to be the lobster claw in the tuna casserole of modern America."

--Tom Robbins

"Krassner loves ironies, especially stinging ironies that nettle public figures. He would rather savor a piquant irony about a public figure than eat a bowl of fresh strawberries and ice cream."

--Ken Kesey

"I told Krassner one time that his writings made me hopeful. He found this an odd compliment to offer a satirist. I explained that he made supposedly serious matters seem ridiculous, and that this inspired many of his readers to decide for themselves what was ridiculous and what was not. Knowing that there were people doing that, better late than never, made me optimistic."

--Kurt Vonnegut

"Mr. Krassner is an expert at ferreting out hypocrisy and absurdism from the more solemn crannies of American culture."

--*The New York Times*

"Krassner has the uncanny ability to alter your perceptions permanently."

--*The Los Angeles Times*

"He has lived on the edge so long, he gets his mailed delivered there."

--*San Francisco Chronicle*

"Krassner lives in a world where Truth and Satire are swingers, changing partners so often you never know who belongs with whom."

--*Playboy*

"Perhaps the satire magazine that most closely resembles *Charlie Hebdo* in terms of inflammatory imagery was *The Realist*, created by Paul Krassner…"

--*Time*

"Paul taught me that extreme stylistic accuracy could make even the most bizarre comedic concept credible. He is a unique character on the American landscape. A self-described 'investigative satirist,' he straddles the lines between politics, culture, pornography and drugs -- in other words, the land where all of us, were we really honest with ourselves, would choose to dwell."

--Harry Shearer

"I have been a fan of his since I was a snot-nosed kid, and his words have been a driving force and influence on my life. If you have read his work before, you know the joys that you are in for. If you haven't, start reading, and consider this your lucky day. For Paul Krassner is an activist, a philosopher, a lunatic and a saint, but most of all he is funny."

--Lewis Black

Many of the pieces in this collection originally appeared in *The Realist, High Times, AVN, N.Y. Press, National Lampoon, The Nation, L.A. Times, Whole Earth Review, Huffington Post, Alternet, CounterPunch,* and *Truthdig.* Several pieces have not been published before, but only for this collection.

For George Carlin, who continues to serve as a satirical touchstone

* * *

"Hypocrisy is better than having no values at all."

--William Bennett, former education czar,
drug czar, morality czar and gambling czar

"MTV actually told us, 'You can make fun of God because he doesn't exist, but you can't make fun of Jesus because he's God's son.'"

--Vernon Chatman & John Lee,
quoted in *Satiristas!*

* * *

Other Books by Paul Krassner

How a Satirical Editor Became a Yippie Conspirator in Ten Easy Years

Best of The Realist [Editor]

The Winner of the Slow Bicycle Race

Impolite Interviews

Psychedelic Trips For the Mind [Editor]

Magic Mushrooms and Other Highs: From Toad Slime to Ecstasy [Editor]

Murder At the Conspiracy Convention and Other American Absurdities

One Hand Jerking

Tales of Tongue Fu

In Praise of Indecency: Dispatches From the Valley of Porn

Who's to Say What's Obscene: Politics, Culture and Comedy in America Today

Pot Stories for the Soul: An Updated Edition for a Stoned America [Editor]

Confessions of a Raving, Unconfined Nut: Misadventures in the Counterculture

Patty Hearst and the Twinkie Murders: A Tale of Two Trials

The Realist Cartoons [Editor]

About the Author

Paul Krassner published *The Realist* (1958-2001), but when *People* magazine labeled him "father of the underground press," he immediately demanded a paternity test. And when *Life* magazine published a favorable article about him, the FBI sent a poison-pen letter to the editor calling Krassner "a raving, unconfined nut." George Carlin responded, "The FBI was right. This man is dangerous—and funny; and necessary." While abortion was illegal, Krassner ran an underground referral service, and as an antiwar activist, he became a co-founder of the Yippies (Youth International Party). Krassner's one-person show won an award from the *L.A. Weekly.* He received an ACLU (Upton Sinclair) Award for dedication to freedom of expression. At the Cannabis Cup in Amsterdam, he was inducted into the Counterculture Hall of Fame — "my ambition," he claims, "since I was three years old." He's won awards from *Playboy*, the Feminist Party Media Workshop, and in 2010 the Oakland branch of the writers organization PEN honored him with their Lifetime Achievement Award. "I'm very happy to receive this award," he concluded in his acceptance speech, "and even happier that it wasn't posthumous."--paulkrassner.com

Introduction by Andy Borowitz

To come . . .

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THE EARLY YEARS

From Carnegie Hall to *MAD* Magazine

I first woke up at the age of six.

It began with an itch in my leg. My left leg. But somehow I knew I wasn't supposed to scratch it. Although my eyes were closed, I was standing up. In fact, I was standing on a huge stage. And I was playing the violin. I was in the middle of playing the "Vivaldi Concerto in A Minor." I was wearing a Little Lord Fauntleroy suit–ruffled white silk shirt with puffy sleeves, black velvet short pants with ivory buttons and matching vest–white socks and black patent-leather shoes. My hair was platinum blond and wavy. On this particular Saturday evening–January 14, 1939–I was in the process of becoming the youngest concert artist in any field ever to perform at Carnegie Hall. But all I knew was that I was being taunted by an itch. An itch that had become my adversary.

I was tempted to stop playing the violin, just for a second, and scratch my leg with the bow, yet I was vaguely aware that this would not be appropriate. I had been well trained. I was a true professional. But that itch kept getting fiercer and fiercer. Then, suddenly, an impulse surfaced from my hidden laboratory of alternative possibilities, and I surrendered to it. Balancing on my left foot, I scratched my left leg with my right foot, without missing a note of the "Vivaldi Concerto."

Between the impulse and the surrender, there was a choice—-I had *decided* to balance on one foot–and it was that simple act of choosing which triggered the precise moment of my awakening to the mystery of consciousness. *This is me!* The relief of scratching my leg was overshadowed by a surge of energy throughout my body. I was being engulfed by some kind of spiritual orgasm. By a wave of born-again ecstasy with no ideological context. No doctrine to explain the shock of my own existence. No dogma to function as a metaphor for the mystery. Instead, I woke up to the sound of laughter.

I had heard that sound before, sweet and comforting, but never like this. Now I could hear a whole *symphony* of delight and reassurance, like clarinets and guitars harmonizing with saxophones and drums. It was the audience laughing. I opened my eyes. There were rows upon rows of people sitting out there in the dark, and they were all laughing together.

They had understood my plight. It was easier for them to identify with the urge to scratch than with a little freak playing the violin. And I could identify with *them* identifying with me. I knew that laughter felt good, and I was pleased that it made the audience feel good–but I hadn't *intended* to make them laugh. I was merely trying to solve a personal dilemma. So the lesson I woke up to–this totally nonverbal, internal

buzz–would serve as my lifetime filter for perceiving reality and its rules. If you could somehow translate that buzz into words, it would spell out: *One person's logic is another person's humor*.

I finished playing "Vivaldi" by rote. Then I bowed to the audience and walked off stage. The applause continued, and I was pushed back on stage by my violin teacher, to play an encore, "Orientale." I had previously asked him–while rehearsing the encore–why it wasn't listed on the program since we already knew that I would play it at the concert. But instead of answering my question, he poked me in the chest, verbalizing each poke: "Violin *up!* Violin *up!*" Now, while playing "Orientale," I heard the echo of his voice, and I automatically raised my violin higher.

Then I popped my ears and the music sounded clearer. I wondered if it sounded clearer to the audience too. They had no idea that their laughter had woken me up. I was overwhelmed by the notion that everybody in the audience had their own individual *This-is-me*, but maybe some of *them* were still asleep and didn't know it. How could you tell who was awake and who was asleep? After all, I hadn't known that *I* was asleep, and look what I accomplished *before* I woke up. If it hadn't been for that itch, I might *still* be asleep.

There was, of course, an objective, scientific explanation for what happened on the stage of Carnegie Hall. According to a textbook, *Physiological Psychology*, "It is now rather well accepted that 'itch' is a variant of the pain experience and employs the same sensory mechanisms." But for me, something beyond an ordinary itch had occurred that night.

It was as though I had been zapped by the god of Absurdity. I didn't even know there was such a concept as absurdity. I simply experienced an overpowering awareness of *something* when the audience applauded me for doing what I had learned while I was asleep. But it was only when they laughed that we had really connected, and I imprinted on that sound. I wanted to hear it again. I was hooked. And the first laugh was free.

A couple of decades later, as if it was inevitable, I sold a few freelance pieces to *Mad* magazine. But when I suggested a satire on the pros and cons of unions, the editor wasn't interested in even seeing it because the subject was "too adult." Since *Mad*'s circulation had already gone over the million mark, publisher Bill Gaines intended to keep aiming the magazine at teenagers.

"I guess you don't wanna change horses in midstream," I said.

"Not when the horse has a rocket up its ass," Gaines replied.

And that moment served as the conception of an irreverent magazine for grown-ups, *The Realist . . .*

A Child’s Primer on Telethons

See the tired man. He has been up all night. He is running a telethon. He wants the people to send money. It is for leukemia. That is a disease. Little children like you can catch it. Evil.

See the sexy girl. She is a singer. She doesn't know whether the telethon is for leukemia or dystrophy or gonorrhea. Her agent got her the booking. She needs the exposure. Notice her cleavage.

See the handsome man. He *does* know that it's for leukemia. You can tell. He is singing a calypso melody. Listen to the lyrics. “Give-your-money,” he sings, “to-leukemia. Give-your-money, to-leukemia.” Listen to the audience applaud. He is very talented.

See the sincere politician. He is running for reelection in November. He is against leukemia. He is willing to take an oath against it. That proves he is against it.

See the wealthy businessman. He is making a donation. He wants his company's name mentioned. Then we can buy his product. Then he will make profits. Then he can make another donation next year. Splendid.

See the little boy. He has leukemia. Too bad for him. The nice lady is holding him up to the TV camera. Aren't you glad it's not you? But wouldn't you like to be on television? Maybe you can fall down a well.

See the pretty scoreboard. It tells how much money they get. They want a million dollars. Uncle Sam has many millions of dollars. He cuts medical research funds by more than seven million dollars. Why? He needs the money for more important things.

See the mushroom cloud. That costs lots of money. It has loads of particles. They cause leukemia. Money might help to find a cure. That is why we have telethons.

See the tired man . . .

Sex Education For the Modern Catholic Child

This is a diaphragm. Women use it when they don't want to have a baby. That is very immoral. Why, you ask? Because it is artificial, that's why. But never fear. There are other methods to prevent conception. They are very moral. Why, you ask? Because they are natural, that's why.

This is big brother's pajama bottoms. He had a nocturnal emission last night. What a shame. It woke him up. But see the semen stain. It has millions of dead sperms. They were killed the natural way.

This is his sister's sanitary napkin. It doesn't look very sanitary any more, does it? There is an ovum somewhere in that bloody mess. But it will never be fertilized. It will be flushed down the toilet bowl. That's the natural way, too.

This is a baby. It was born dead. Every day in the U.S.A., 136,000 infants are stillborn or die within a month. Now suppose their Mommies and Daddies had interfered artificially with the process of procreation. God's purpose would never have been achieved. Just think what a tragedy that would've been. But at least some of the dead babies were baptized. That's the natural way.

This is a special calendar. It marks off menstrual periods. That' s for the rhythm system of not having babies. A husband and his wife are in bed. They start to make love. Then they get out of bed. Because they have to look at the calendar. That' s the natural way.

This is a husband and wife who don' t want to have a baby yet. But the calendar says that the time is fertile. So they stop making love. Because one thing would lead to another. Ask [advice columnist] Dorothy Dix. She should know. She tried it once with [advice columnist] Dr. Crane. Just to prove her theory. Later she had to write to his Worry Clinic. She was worried because she missed her period. She missed it very much.

This is a husband and wife who *do* want to have a baby. But the calendar says that the time is sterile. Lucky for them they have a calendar. It saves them from having unnecessary intercourse. Unless they like to gamble on having unwanted babies. That' s the natural way.

This is a confessional booth. There is a screen in the middle. The person on one side is a priest. The person on the other side is a confessor. He is confessing that he has had evil thoughts. The priest tells him that to have an evil thought is evil. It is just as evil as committing the evil act that the evil thought is about. Priests never have evil thoughts themselves. They

don't have to. They have an ample supply of other people's evil thoughts to draw upon.

This is the husband and his wife again. The ones who don't want to have a baby yet. Now the calendar says that the time is sterile. How convenient. Now they can make love without stopping. And without worrying. But they're good, consistent Catholics. And so they *are* worrying. Because they know that evil thoughts are evil. Their evil thought is to have intercourse but to avoid having a baby. They can't be *sure* they won't have a baby--that's why the rhythm system is moral--but the *intention* is there. Tomorrow they will go to confession.

Postscript:

I wrote the above piece in 1958 (before the Pill), and it turned out to be theologically correct in 1984, when Pope John Paul II warned that the rhythm method of birth control can be "an abuse if the couple is seeking in this way to avoid children for unworthy reasons."

A Child’s Primer on Fighting Communism

Now we are going to have some fun fighting Communism. Let us play a game of Make Believe. Close your eyes and concentrate. We are going to pretend that Red China doesn’t exist. They are the Bad Guys. Because they make people slaves.

Nationalist China is different. They are the Good Guys. There, hundreds of thousands of little unwanted children are sold. They work in coal mines. Then they are wanted. The older girls work in brothels. How nice to be so wanted. Open your eyes now. Anyone around our base is *it*.

Fidel Castro says Cuba is a socialist state. That proves they are Communists. But we knew it before. You could tell by the way Castro and Khrushchev hugged each other. So we stopped buying sugar from Cuba. Now other countries buy sugar from Cuba.

Iran has bought 10,000 tons of sugar from Cuba. Iran gets a lot of economic and military aid from us. So we are helping Cuba anyway. Maybe we should trade tractors for prisoners then. But we will fool them. We will put treads on all the old Edsels that didn’t sell.

There are Communists in the United States too. They are dangerous. So the Supreme Court says they have to register as foreign agents. Otherwise they have to go to jail. So they register as foreign agents. Then they have to go to jail under the Smith Act.

So the Communist Party isn't very much fun to belong to any more. But there's a way to belong without going to jail. You have to join the FBI first. Most of the members do it that way. J. Edgar Hoover is the head of the Communist Party.

Why are Communists such a threat to us? Because they advocate the violent overthrow of the government. That is why Governor Rockefeller wrote his name on the bottom of a new law. Now anyone who gets convicted in Federal Court for advocating the violent overthrow of the government will lose his driver's license.

That law was passed in April 1961. But on the 4th of July holiday the United States broke all previous traffic accident records. More people got killed in cars than ever before. The roads are still full of dangerous Communist spies.

How can we defeat Communism all over the world? By foreign aid. That turns Neutral Guys into Good Guys. Meanwhile there is a great big famine in Red China. So Canada will ship wheat to them. But special

machinery is needed for this. It is made in America. And the U.S. Justice Department doesn't allow such sales. Because Bad Guys deserve to starve. Everybody knows that. Especially the Neutral Guys.

So Canada shouldn't be mad at us. Didn't President Kennedy plant a tree there? That's personal diplomacy. It has nothing to do with hungry human beings in Red China. The way to avoid feeling guilty about suffering people is just don't recognize them.

A Child's Primer on Divorce

Oh, look. Mommy and Daddy are having another fight. Is it just an attention-getting device this time? Listen. They are having an adult discussion. They are agreeing on a separation. That means you will come from a broken home. What a shame. Even if they fight all the time they should stay together for your sake. Now you will be insecure.

Mommy and Daddy are modern people. They drink Pepsi-Cola. They also have a modern marriage. They left the word "obey" out of their wedding ceremony. Wasn't that modern? But they didn't leave out the words "love" and "honor." Mommy and Daddy are only modern, not avant-garde. They left "till death do us part" in the ceremony, too. But they are going to get a divorce anyway. They don't have to *obey* their marriage vows. Lucky thing they left out that word.

What is to be done to keep Mommy and Daddy together? The *Ladies' Home Journal* will help. They have a regular feature in their magazine. It is called "Can This Marriage Be Saved?" Readers send in Betty Crocker boxtops and try to guess the correct answer.

Maybe Mommy and Daddy will go on television. There is a program all about *Divorce Court*. Dr. Paul Popenoe is the master of ceremonies. He

wears glasses. Sometimes while the commercial is on, the actors have reconciliation. It is a real fun show.

Mommy and Daddy live in New York State. To get a divorce there, one of them has to commit adultery. Daddy has a tryst with a girl. Mommy raids the joint. She brings along a photographer. Mommy has secretly been having an affair with the photographer. What Daddy doesn't know won't hurt him. He always wanted to be on Page 3 of the *Daily News* anyhow. Mommy made sure that his undershorts were ironed.

Benjamin Brenner lives in Brooklyn. He is a Supreme Court Justice there. He makes decisions. He decided that raiding the joint is illegal from now on. Unless you have a search warrant. Then it's legal, but you have to knock first and say, "Benny sent me." This new rule doesn't count for hotel rooms. Then it's okay to raid the joint. So Daddy better get his own apartment. Judge Brenner is really under the thumb of real-estate agents.

There is another way. Mommy can go to Reno. She lives there for six weeks. That is called "establishing residence." Reno is Keno but Alabama is Clamor. Same-day service. The Chamber of Commerce invites lawyers to practice there. They are promised the run of the divorce mill. More people are traveling to Alabama than ever before. They are called Freedom Riders.

Here comes the governor of New York. See him eat the potato knish. He wants to get a divorce. He will establish residence in another state. But then he can't be governor. Instead he will get a divorce in New York. But you know what that means. Dirty, dirty. Some deserving Young Republican girl will get the assignment. This is known as political patronage. The governor has a horny dilemma, though. Either he commits scandal or he commits perjury. Maybe he will propose a new law.

RELIGION FOR DUMMIES

Pope Endorses Condoms

When I was a kid, condoms were called prophylactics, prophylactics were called rubbers, and rubbers were called scumbags. My friends and I would find used scumbags in a vacant lot or in the alley between buildings. Once, while snooping, I found a large package of unused prophylactics in my father's sock drawer. It must have held a dozen. Now there were nine left. Each was tightly rolled, bound by a miniature cigar-like band. I selected one, took the band off, and carefully unrolled it.

There was a legend imprinted on the prophylactic: "Sold in Drug Stores Only For the Prevention of Disease." What hypocrisy! They were sold for the prevention of *pregnancy*, which is a condition, not a disease. The irony is that now condoms *don't* carry that message but they *are* used for the prevention of disease. Anyway, I tried to re-roll my father's prophylactic and stuff it back into the band, but it was a losing battle, so I decided not to put it back in the package, figuring that my dad wasn't counting his condoms and would never know.

As an adolescent, I found that purchasing condoms was a traumatic experience. I would buy other stuff to avoid being embarrassed. "I'd like a *Batman* comic book, and this Snickers candy bar, and [*whispering*] a

pack of Trojans, and a tube of Crest toothpaste, please." But four decades later there were huge billboards, warning: "If you can't say no, use condoms." However, an executive of the Gannett Outdoor Advertising Company confirmed that they held off putting up those signs until after a visit by the Pope.

Members of the Roman Catholic Church hierarchy have been faced with an interesting dilemma. On the one hand, they are opposed to condoms as an artificial method of birth control. On the other hand, they are aware that condoms can serve as a protection against AIDS. But a group of bishops issued a statement that educational programs which include information about condoms should also stress that they are morally incorrect.

That's sort of like in the Watergate scandal when Richard Nixon said, "We could get the million dollars—but that would be *wrong*."

Coincidentally, in November 2010, while the porn industry in California was being pressured to require all male actors to wear condoms to prevent AIDS, in the Vatican it was revealed that, for the exact same reason, Pope Benedict--in his official capacity as the Church's chief spin doctor--went on record proclaiming that under some circumstances it might be acceptable for a (male) prostitute to use a condom.

"There can be single justified cases," he rationalized, "for example, when a prostitute uses a condom, and this can be a first step toward a moralization, a first act of responsibility in developing anew an awareness of the fact that not everything is permissible and that we cannot do everything we want. However, this is not the best way to overcome the infection of HIV. It is really necessary to humanize sexuality."

Daniel Maguire, author of *Sacred Rights: The Case for Contraception and Abortion in World Religions*, observed that the pope's change in policy represents a significant "crack in the dike" of Catholic opposition to condom use. The opposition stems from Catholic dogma that sex is for reproduction, and nothing should interfere with that.

An issue of *The Realist* reprinted an article from the *London Observer,* which began: "Three Roman Catholic theologians have expressed the opinion that, in times of revolution and violence, it is lawful for women, particularly for nuns, to take contraceptive pills and precautions against the danger of becoming pregnant through rape."

On that same page was our *Rumor of the Month*: "So-called 'flying saucers' are actually diaphragms being dropped by nuns on their way to Heaven."

I Ran an Underground Abortion Referral Service

When abortion was illegal, women had no choice but to seek out back-alley butchers for what should have been a medical procedure in a sterile environment. If there was a botched surgery and the victim went to a hospital, the police were called and they wouldn't allow the doctor to provide a painkiller until the patient gave them the information they sought.

In 1962, there was an article in *Look* magazine that stated, "There is no such thing as a 'good' abortionist. All of them are in business strictly for money." But in an issue of *The Realist*, I published an anonymous interview with Dr. Robert Spencer, a truly humane abortionist, promising that I would go to prison sooner than reveal his identity.

He had served as an Army doctor in World War I, then became a pathologist at a hospital in Ashland, Pennsylvania. He went down into the shafts after a mine accident, and aided miners to obtain Workmen's Compensation for lung disease. At a time when 5,000 women were killed each year by criminal abortionists who charged as much as $1500, his

reputation had spread by word-of-mouth, and he was known as "The Saint." Patients came to his clinic in Ashland from around the country.

I took the five-hour bus trip from New York to Ashland with my gigantic Webcor tape recorder. Dr. Spencer was the cheerful personification of an old-fashioned physician. He wore a red beret and used folksy expressions like "by golly." He had been performing abortions for 40 years. He started out charging $5, and never more than $100. He rarely used the word *pregnant*. Rather, he would say, "She was *that way*, and she came to me for help."

Ashland was a small town, and Dr. Spencer's work was not merely tolerated; the community *depended* on it—the hotel, the restaurant, the dress shop—all thrived on the extra business that came from his out-of-town patients. However, he built facilities at his clinic for African-American patients who weren't allowed to obtain overnight lodgings elsewhere. The walls of his office were decorated with those little wooden signs that tourists like to buy. A sign on the ceiling over his operating table said *Keep Calm*.

Here's an excerpt from our dialogue:

Q. Do you have any idea about how many actual abortions you're performed during all these years?

A. To be accurate, it' s 27,006

Q. Have medical people come to you, who would otherwise shun you?

A. Oh, yes, I' ve had medical people who bring me their wives, and I' ve had quite a few medical people send me patients.

Q. But they wouldn' t perform the operation themselves?

A. No, they' d never perform it, and just exactly what their attitude would be, I don' t really know. Some of them, I presume, were absolutely against it, because I' ve had ministers, and they' d bring me their daughters or their nieces.

Q. Have police come to you for professional services?

A. Oh, yes, I' ve had police in here, too. I' ve helped them out. I' ve helped a hell of a lot police out. I' ve helped a lot of FBI men out. They would be here, and they had me a little bit scared--I didn' t know whether they were just in to get me or not.

Q. What would you say is the most significant lesson you' ve learned in all your years as a practicing abortionist?

A. You' ve got to be careful. That' s the most important thing. And you' ve got to be cocksure that everything' s removed. And even the uterus speaks to you and tells you. I could be blind. You see, this is an

operation no eye sees. You go by the sense of feel and touch. The voice of the uterus. But the only thing I can see is hypocrisy, hypocrisy. Everywhere I look is hypocrisy, Because the politicians--and I' ve had politicians in here--they still keep those laws in existence, but yet, if some friend of theirs is in trouble...

Even priests came to his clinic with the housekeepers they had impregnated. As if to retroactively approve of such hypocrisy, the *Colorado Independent* reported in 2013 that "A chain of Catholic hospitals has beaten a malpractice lawsuit by saying that fetuses are not equivalent to human lives." Their attorneys argued that in cases of wrongful death, the term "person" only applies to individuals born alive, and not those who die in utero.

After the issue of *The Realist* featuring that interview with Dr. Spencer was published, I began to get phone calls from scared female voices. They were all in desperate search of a safe abortionist. It was preposterous that they should have to seek out the editor of a satirical magazine, but their quest so far had been futile, and they simply didn't know where else to turn.

With Dr. Spencer's permission, I referred them to him. At first there were only a few calls each week, then several every day. I had never

intended to become an underground abortion referral service, but it wasn't going to stop just because in the next issue of *The Realist* I would publish an interview with somebody else.

A few years later, state police raided Dr. Spencer's clinic and arrested him. He remained out of jail only by the grace of political pressure from those he'd helped. He was finally forced to retire from his practice, but I continued mine, referring callers to other physicians that he had recommended. Occasionally I would be offered money by a patient, but I never accepted it. And whenever a doctor offered me a kickback, I refused, but I also insisted that he give a discount for the same amount to those patients referred by me.

Eventually, I was subpoenaed by district attorneys in two cities to appear before grand juries investigating criminal charges against abortionists. On both occasions I refused to testify, and each time the D.A. tried to frighten me into cooperating with the threat of arrest.

In Liberty, New York, my name had been extorted from a patient by threatening *her* with arrest. The D.A. told me that the doctor had confessed everything and they got it all on tape. He gave me until two o'clock that afternoon to change my mind about testifying, or else the police would come to take me away.

"I'd better call my lawyer," I told him.

I went outside to a public phone booth and called, not a lawyer, but the doctor.

"That never happened," he said.

I returned to the D.A.'s office and told him that my lawyer said to continue being uncooperative. Then I just sat there waiting for the cops.

"They're on their way," the D.A. kept warning me. But at two o'clock, he simply said, "Okay, you can go home now."

Bronx District Attorney (later Judge) Burton Roberts took a different approach. In September 1969, he told me that his staff had found an abortionist's financial records, which showed all the money that I had received, but he would grant me immunity from prosecution if I cooperated with the grand jury. He extended his hand as a gesture of trust.

"That's not true," I said, refusing to shake hands with him.

If I *had* ever accepted any money, I'd have no way of knowing that he was bluffing. The D.A. was angry, but he finally had to let me go.

Attorney Gerald Lefcourt (later president of the National Association of Criminal Defense Lawyers) filed a suit on my behalf, challenging the constitutionality of the abortion law. He pointed out that the district

attorney had no power to investigate the violation of an unconstitutional law, and therefore he could not force me to testify.

In 1970, I became the only plaintiff in the first lawsuit to declare the abortion laws unconstitutional in New York State. "Later, various women's groups joined the suit," Lefcourt recalls, "and ultimately the New York legislature repealed the criminal sanctions against abortion, prior to the Supreme Court decision in *Roe vs. Wade*."

Dr. Spencer never knew about that. He had died in 1969. The obituary in the *New York Times* acknowledged the existence of his abortion clinic. The obituary in the local paper in Ashland did not.

I continued to carry on my underground abortion referral service. Each time, though, I would flash on the notion that this was my *own* mother asking for help, and that she was pregnant with *me*. I would try to identify with the fetus that was going to be aborted even while I was serving as a conduit to the performance of that very abortion. Every day I would think about the possibility of never having existed, and I would only appreciate being alive all the more.

Of course, I couldn't possibly have known the difference if my fetus had been aborted. Pretending to be the fetus was just a way of focusing on my role as a referral service. I didn't want it to become so casual that I

would grow unaware of the implications. By personalizing it, I had to accept my own responsibility for each fetus whose potential I was helping to disappear. That was about as mystical as I got. Maybe I was simply projecting my own ego.

In any case, by the time these women came to me for help, they had *already* searched their souls and made up their minds. This was not some abstract cause far away–-these were real people in real distress--and I just couldn't say no. For nearly a decade, that became my fetal yoga. And, in the process, I had evolved from a satirist into an activist.

There Are No Atheists in the White House

It was God who instructed Bill O' Reilly to consider every utterance of "Happy Holidays" to be a verbalization of "the war on Christmas." Whenever anybody claims that God talks directly to them, I think they're totally delusional. George W. Bush is no exception. Not only was he told by his senior adviser, Karen Hughes, not to refer to terrorists as "folks," but Bush was also being prompted by God Him-Her-or-Itself: "God would tell me, 'George, go and end the tyranny in Iraq.' And I did." As if he were merely following divine orders.

In July 2003, during a meeting with Palestinian Prime Minister Mahmoud Abbas, Bush told the newly elected leader, "God told me to strike at Al-Qaeda and I struck them, and then He instructed me to strike at Saddam, which I did. And now I am determined to solve the problem in the Middle East. If you help me, I will act, and if not, the elections will come and I will have to focus on them."

Abu Bakar Bashir, an Islamic cleric and accused terrorist leader, has said that "America's aim in attacking Iraq is to attack Islam, so it is justified for Muslims to target America to defend themselves." That's exactly interchangeable with this description of Bush by an unidentified

family member, quoted in the *Los Angeles Times*: "George sees [the war on terror] as a religious war. His view is that they are trying to kill the Christians. And the Christians will strike back with more force and more ferocity than they will ever know."

Indeed, General William Boykin, Deputy Undersecretary of Defense for Intelligence, said that "George Bush was not elected by a majority of the voters in the United States, he was appointed by God." Discussing the battle against a Muslim warlord in Somalia, Boykin explained, "I knew my God was bigger than his. I knew that my God was a real God and his was an idol."

Apparently, religious bigotry runs in the family. Bush's father, the former president: "I don't know that atheists should be considered citizens, nor should they be considered patriots. This is one nation under God." And before him, there was Ronald Reagan: "For the first time ever, everything is in place for the Battle of Armageddon and the Second Coming of Christ." Not to mention Reagan's Secretary of the Interior, James Watt, responsible for national policy on the environment: "We don't have to protect the environment--the Second Coming is at hand."

In 1966, Lyndon Johnson told the Austrian ambassador that the diety "comes and speaks to me about two o'clock in the morning when

I have to give the word to the boys, and I get the word from God whether to bomb or not." So maybe there's some kind of bipartisan theological tradition going on in the White House.

But if these leaders are *not* delusional, then they're deceptive. And in order to deceive others, one must first deceive oneself until self-deception morphs into virtual reality. In any case, we have *our* religious fanatics, and they have *theirs*. In September 2007, on the eve of the sixth anniversary of 9/11, Osama bin Laden warned the American people that they should reject their capitalist way of life and embrace Islam to end the Iraq war, or else his followers would "escalate the killing and fighting against you."

George Bush once proclaimed, "God is not neutral," which is the antithesis of my own spiritual path, my own peculiar relationship with the universe--based on the notion that God is *totally* neutral--though I've learned that whatever people believe in, works for them.

My own belief in a deity disappeared when I was thirteen. I was working early mornings in a candy store across the street from our apartment building. My job was to insert different sections of the newspaper into the main section. On the day after the United States dropped the first atomic bomb on Hiroshima, I would read that headline

over and over and over again while I was working. That afternoon, I told God I couldn't believe in him any more because--even though he was supposed to be a loving and all-powerful being--he had allowed such devastation to happen. And then I heard the voice of God:

"ALLOWED? WHY DO YOU THINK I GAVE HUMANS FREE WILL?"

"Okay, well, I'm exercising my free will to believe that you don't exist."

"ALL RIGHT, PAL, IT'S YOUR LOSS!"

At least we would remain on speaking terms. But I knew it was a game. I enjoyed the paradox of developing a dialogue with a being whose reality now ranked with that of Santa Claus. Our previous relationship had instilled in me a touchstone of objectivity that could still serve to help keep me honest. I realized, though, that whenever I prayed, I was only talking to myself.

The only thing I can remember from my entire college education is a definition of philosophy as "the rationalization of life." For my term paper, I decided to write a dialogue between Plato and an atheist. On a whim, I looked up Atheism in the Manhattan phone book, and there it was: "Atheism, American Association for the Advancement of." I went to their office for background material.

The AAAA sponsored the Ism Forum, where anybody could speak about any "ism" of their choice. I invited a few friends to meet me there. The event was held in a dingy hotel ballroom. There was a small platform with a podium at one end of the room and heavy wooden folding chairs lined around the perimeter. My favorite speaker declared the Eleventh Commandment: "Thou shalt not take thyself too goddamned seriously." Taking that as my unspoken theme, I got up and parodied the previous speakers. The folks there were mostly middle-aged and elderly. They seemed to relish the notion of fresh young blood in their movement.

However, my companions weren't interested in staying. If I had left with them that evening in 1953, the rest of my life could have taken a totally different path. Instead, I went along with a group to a nearby cafeteria, where I learned about the New York Rationalist Society. A whole new world of disbelief was opening up to me. That Saturday night I went to their meeting. The emcee was a former circus performer who entertained his fellow rationalists by putting four golf balls into his mouth. He also recommended an anti-censorship paper, *The Independent*.

The next week, I went to their office to subscribe and get back issues. I ended up with a part-time job, stuffing envelopes for a dollar an hour. My apprenticeship had begun. The editor, Lyle Stuart, was the most

dynamic individual I' d ever met. His integrity was such that if he possessed information that he had a vested interest in keeping quiet--say, corruption involving a corporation in which he owned stock--it would become top priority for him to publish. Lyle became my media mentor, my unrelenting guru, and my closest friend. He was responsible for launching *The Realist*. The masthead announced, "Freethought Criticism and Satire."

* * *

In the words of the late Jerry Falwell--who once said that God is pro-war-- "If you' re not a born-again Christian, you' re a failure as a human being." We salute, then, a few *successful* human beings:

*The individual who placed the winning bid of $1800 on eBay for a slab of concrete with a smudge of driveway sealant resembling the face of Jesus.

*The man who tried to crucify himself after seeing "pictures of God on the computer." He took two pieces of wood, nailed them together in the form of a cross and placed it on his living-room floor. He proceeded to hammer one of his hands to the crucifix, using a 14-penny nail. According to a county sheriff spokesperson, "When he realized that he was unable

to nail his other hand to the board, he called 911." It was unclear whether he was seeking assistance for his injury or help in nailing his other hand.

*The Sunday School teacher who advised one of his students to write on his penis, "What would Jesus do?" Presumably, "Masturbate" was not considered to be the correct answer.

*And, of course, the anonymous authors of the following quotes from various state constitutions. Arkansas: "No person who denies the being of a God shall hold any office." Mississippi: "No person who denies the existence of a Supreme Being shall hold any office in this state." North Carolina: "The following persons shall be disqualified for office: First, any person who shall deny the being of Almighty God." South Carolina: "No person shall be eligible to the office of Governor who denies the existence of the Supreme Being." Tennessee: "No person who denies the being of God, or a future state of rewards and punishments, shall hold any office in the civil department of this state." Texas: "Nor shall any one be excluded from holding office on account of his religious sentiments, provided he acknowledge the existence of a Supreme Being."

Rick Warren, pastor of America's fourth-largest church, told his congregation, "I could not vote for an atheist because an atheist says, 'I don't need God.'"

In 2006, the Secular Coalition of America offered a $1,000 prize to anyone who identified the highest-ranking non-theist public official in the country. Almost 60 members of Congress were nominated, out of which 22 confided that they didn't believe in a Supreme Being, but they wanted their disbelief kept secret. Only Pete Stark admitted that he was a nonbeliever, and in 2007, he became the first member of Congress ever to identify himself publicly as a nonbeliever.

In the week following that announcement, he received over 5,000 emails from around the globe, almost all congratulating him for his courage. "Like our nation's founders," he stated, "I strongly support the separation of church and state. I look forward to working with the Secular Coalition to stop the promotion of narrow religious beliefs in science, marriage contracts, the military and the provision of social services." In 2008, he was elected to his 19th term with 76.5% of the votes.

In the 2008 primaries, three presidential wannabes raised their hands during a Republican "debate" to signify that they didn't believe in evolution, although one of them, Mike Huckabee, admitted, "I don't know if the world was created in six days. I wasn't there." He has also said that, "If there was ever an occasion for someone to have argued

against the death penalty, I think Jesus could have done so on the cross and said, 'This is an unjust punishment, and I deserve clemency.' "

Such western fundamentalists have been waging a battle against the teaching of meditation in publicly funded schools, as though slow, deep breathing is inextricably connected with the practice of eastern religious disciplines. What's next, forbidding the teaching of empathy because that's what Christians and Jews are supposed to practice?

It was a pleasant surprise when Barack Obama acknowledged "unbelievers" among others in his inauguration speech. However, I don't exempt unbelievers from criticism.

I ridicule officially atheist China's leaders for banning Tibet's living Buddhas from reincarnation without permission. According to the order, issued by the State Administration for Religious Affairs, "The so-called reincarnated living Buddha without government approval is illegal and invalid." That regulation is aimed at limiting the influence of the Dalai Lama, even though China officially *denies* the possibility of reincarnation. (I used to believe in reincarnation, but that was in a previous lifetime.)

China is a Big-Brother, slave-labor-driven, human-rights-violator, Maoist dictatorship, from which the United States borrows trillions, then

proceeds to purchase their poisoned food, leaded Christmas toys, and "Made in China" American flags.

America remains a living paradox, where our citizens are force-fed misinformation and disinformation, so that we can continue to fund incompetent and illegal activities in the U.S.--even though our revolution was fought because of taxation without representation. And yet I live in this country where at least I still have complete freedom to openly condemn the government, the corporations and organized religions that continue enabling each other to reek with greed, corruption, and inhumanity.

THE SEX LIFE OF PRESIDENTS & OTHERS

The Parts Left Out of the Kennedy Book

An executive in the publishing industry, who obviously must remain anonymous, has made available to The Realist *a photostat copy of the original manuscript of William Manchester's book,* The Death of a President*. Those passages which are printed here were marked for deletion months before Harper & Row sold the serialization rights to* Look *magazine; hence they do not appear even in the so-called "complete" version published by the German magazine* Stern.

#

At the Democratic National Convention in the summer of 1960, Los Angeles was the scene of a political visitation of the alleged sins of the father upon the son. Lyndon Johnson found himself battling for the presidential nomination with a young, handsome, charming and witty adversary, John F. Kennedy.

The Texan in his understandable anxiety degenerated to a strange campaign tactic. He attacked his opponent on the grounds that his father, Joseph P. Kennedy, was a Nazi sympathizer during the time he was United States Ambassador to Great Britain, from 1938 to 1940. The senior Kennedy had predicted that Germany would defeat England and he

therefore urged President Franklin D. Roosevelt to withhold aid. Now Johnson found himself fighting pragmatism with pragmatism. It did not work; he lost the nomination.

Ironically, the vicissitudes of regional bloc voting forced Kennedy into selecting Johnson as his running mate. Jack rationalized the practicality of the situation, but Jackie was constitutionally unable to forgive Johnson. Her attitude toward him always remained one of controlled paroxysm.

It was common knowledge in Washington social circles that the Chief Executive was something of a ladies' man. His staff included a Secret Service agent, referred to by the code name *Dentist*, whose duties virtually centered around escorting him to and from a rendezvous site--either in the District of Columbia or while traveling--the models, actresses and other strikingly attractive females chosen by the president for his not-at-all infrequent trysts. "Get me that," he had said of a certain former Dallas beauty contest winner when plans for the tour were first being discussed. That particular aspect of the itinerary was changed, of course, when Mrs. Kennedy decided to accompany her husband.

She was aware of his philandering, but would cover up her dismay by joking, "It runs in the family." The story had gotten back to her about

the late Marilyn Monroe using the telephone in her Hollywood bathroom to make a long distance call to *New York Post* film-gossip columnist Sidney Skolsky.

"Sid, you won't believe this," she had whispered, "but the Attorney General of our country is waiting for me in my bed this very minute--I just had to tell you."

* * *

It is difficult to ascertain where on the continuum of Lyndon Johnson's personality innocent boorishness ends and deliberate sadism begins. To have summoned then-Secretary of the Treasury Douglas Dillon for a conference wherein he, the new president, sat defecating as he spoke, might charitably be an example of the former; but to challenge under the same circumstances Senator J. William Fulbright for his opposition to Administration policy in Vietnam is considered by insiders to be a frightening instance of the latter. The more Jacqueline Kennedy has tried to erase the crudeness of her husband's successor from consciousness, the more it has impinged upon her memories and reinforced her resentment.

"It's beyond style," she would confide to friends. "Jack had style, but this is beyond style."

When Arthur Schlesinger, Jr. related to her an incident that he had witnessed firsthand--Mr. Johnson had actually placed his penis over the railing of the yacht, bragging to onlookers, "Watch it touch bottom!" --Mrs. Kennedy could not help but shiver with disgust. Capitol Hill reporters have observed the logical extension of Mr. Johnson boasting about his six-o'clock-in-the-morning forays with Lady Bird, to his bursts of phallic exhibitionism, whether it be on a boat or at the swimming pool or in the lavatory. Apropos of this tendency, Drew Pearson's assistant, Jack Anderson, has remarked: "When Lyndon announces there's going to be a joint session of Congress, everybody cringes."

It is true that Mrs. Kennedy withstood the pressures of publicized scandal, ranging from the woman who picketed the White House carrying a blown-up photograph supposedly of Jack Kennedy sneaking away from the home of Jackie's press secretary, Pamela Turnure, to the *Blauvelt Family Genealogy* which claimed on page 884, under Eleventh Generation, that one Durie Malcolm had "married, third, John F. Kennedy, son of Joseph P. Kennedy, one time Ambassador to England." But it was the personal infidelities that gnawed away at her--as indeed they would gnaw away at *any* wife who has been shaped by this culture--until finally Jackie left in exasperation. Her father-in-law offered her one million dollars to

reconcile. She came back, not for the money, but because she sincerely believed that the nation needed Jack Kennedy, and she didn't want to bear the burden of losing enough public favor to forestall his winning the presidency.

Consequently she was destined to bear a quite different burden--with great ambivalence--the paradox of fame. She enjoyed playing her role to the hilt, but complained, "Can't they get it into their heads that there's a difference between being the First Lady and being Elizabeth Taylor?" Even after she became First Widow, the movie magazines would not--or could not--leave her alone. Probably the most bizarre invasion of her privacy occurred in *Photoplay*, which asked the question, "Too Soon for Love?" --then proceeded to print a coupon that readers were requested to answer and send in. They had a multiple choice: "Should Jackie (1) Devote her life exclusively to her children and the memory of her husband? (2) Begin to date--privately or publicly--and eventually remarry? (3) "Marry right away?" Mrs. Kennedy fumed. "Why don't they give them some *more* decisions to make for me? Some *real* ones. Should I live in occasional sin? Should I use a diaphragm or the pill? Should I keep it in the medicine cabinet or the bureau drawer?" But she would never lose her dignity in public; she had too deep a faith in her own image.

* * *

American leaders seem to have a schizophrenic approach toward each other. They *want* to expose their human frailties at the same time that they do *not* want to remove them from their pedestals. Bobby Kennedy privately abhors Lyndon Johnson, but publicly calls him "great, and I mean that in every sense of the word." Johnson has referred to Bobby as "that little shit" in private, but continues to laud him for the media. Gore Vidal has no such restraint. On a television program in London, he explained why Jacqueline Kennedy would never relate to Lyndon Johnson. During that tense flight from Dallas to Washington after the assassination, she inadvertently walked in on him as he was standing over the casket of his predecessor and chuckling. This disclosure was the talk of London, but did not reach these shores.

Of course, President Johnson is often given to inappropriate response--witness the puzzled timing of his smiles when he speaks of grave matters--but we must also assume that Mrs. Kennedy had been traumatized that day and her perception was likely to have been tainted by the tragedy. This state of shock must have underlain an incident on Air Force One which this writer conceives to be delirium, but which Mrs. Kennedy insists she actually saw. "I'm telling you this for the historical

record," she said, "so that people a hundred years from now will know what I had to go through."

She corroborated Gore Vidal's story, continuing: "That man [Johnson] was crouching over the corpse, no longer chuckling but breathing hard and moving his body rhythmically. At first I thought he must be performing some mysterious symbolic rite he'd learned from Mexicans or Indians as a boy. And then I realized--there is only one way to say this--he was literally fucking my husband in the throat. In the bullet wound in the front of his throat. He reached a climax and dismounted. I froze. The next thing I remember, he was being sworn in as the new president."

[Handwritten marginal notes: *1. Check with Rankin--did secret autopsy show semen in throat wound? 2. Is this simply necrophilia, or was LBJ trying to change entry wound from grassy knoll into exit wound from Book Depository by enlarging it?*]

The glaze lifted from Jacqueline Kennedy's eyes.

"I don't believe that Lyndon Johnson had anything to do with a conspiracy, but I do know this--Jack taught me about the nuances of power--if he were miraculously to come back to life and suddenly appear

in front of him, the first thing Johnson would do *now* is kill him." She smiled sardonically, adding, "Unless Bobby beat him to it."

Postscript:

The most significant thing about "The Parts Left Out of the Kennedy Book" was its widespread *acceptance*--if only for a moment--by intelligent, literate people, from an ACLU official to a Peabody Award-winning journalist to members of the intelligence community who knew that sort of thing actually *does* go on. Daniel Ellsberg said, "Maybe it was just because I *wanted* to believe it so badly."

One caller claimed that he could determine, by feeding the article into a computer, whether Manchester had written the portions I published. Several individuals queried that final arbiter of truth, the *Playboy* Adviser. One reader "went out and bought the original *Death of a President* just to see if your parts would fit into the book--they did. Amazing!"

I also received a call from Ray Marcus, a critic of the *Warren Commission Report*, who had discovered a chronological flaw in my article. How could William Manchester leave something out of his book that was itself a *report* of something that he' d left out of his book? Marcus deduced that *The Realist* must have been given the excerpts by a CIA operative in order to discredit *valid* dissent on the assassination.

My favorite response came from Merriman Smith, the syndicated UPI correspondent who always ended White House press conferences with the traditional "Thank you, Mr. President." He wrote:

"One of the filthiest printed attacks ever made on a President of the United States is now for sale on Washington newsstands. The target: President Johnson. This is the May edition of a so-called magazine which says it is entered as second class mail. One newsstand owner says sales of this particular issue have been 'quite active.' This reporter is not embarked here on any defense of Johnson politically or personally, nor, for that matter, is this to suggest the need for greater respect for the presidency.

"These are matters that have been dealt with extensively in other forums. Certain unadorned facts, however, do stand out in the open circulation, mailing and other forms of distribution of this sort of slime: If a magazine of major national standing tries to use the same sort of language, federal action to stop it would be almost certain. The language referred to is not conventional hell or damn profanity–-it is filth attributed to someone of national stature supposedly describing something Johnson allegedly did. The incident, of course, never took place . . ."

A Sneak Preview of Richard Nixon's Memoir

An old friend approached us with a thick sheaf of what was purported to be a photocopy of the autobiographical manuscript on which former President Richard M. Nixon was still at work. Our first reaction was skepticism. While most of the contents dealt predictably with contemporary history as it has already been recorded, there were enough surprises to shock even our own jaded psyche.

Just to be sure, we employed the services of a reputable private investigative firm. Their report verified that our source did indeed know an individual inside the San Clemente hideaway. The next step was to hire a professional graphologist, who determined the authenticity of Mr. Nixon's handwritten notes on the typed transcript. Finally, our attorneys assured us that there was no violation of copyright laws involved, because it was unlikely that Nixon had submitted such unfinished material for copyright protection.

The book, as yet untitled, is dedicated "To Patricia Ryan Nixon, who has been named the most admired women in the country, and deservedly so, for your loyalty has been a continuing inspiration, not only to your

husband and family, but to Americans everywhere." Here, then, are several excerpts from this preliminary draft of the memoirs of the only United States president ever to resign from office.

#

Although President Dwight David Eisenhower encouraged me to call him Ike during the years I served as Vice President, it was a superficial form of intimacy. I regretted his failure to share decision-making responsibility with me at the White House. That privilege he reserved for his special assistant, Sherman Adams.

When media coverage of a minor scandal in 1958 involving a rug and a vicuna coat pressured him into letting Adams go, Ike at last revealed a facet of his humanity to me. "By sheer force of habit," he remarked, "I was ready to seek out Sherman's advice on whether or not I should fire him."

It was not until 1961, after Ike's farewell address, that he confided in me again, this time about a more momentous occasion. "I suppose," he began, "my reference to the dangers of the military-industrial complex in my speech came as something of a surprise to you, eh?"

"Well, sir, it did strike me as a rather incongruous position for a renowned Army general to take--"

"I had a visitation," he interrupted, "while I was in the process of composing my farewell address—now this is utterly impossible to describe—but I do believe it was some kind of extraterrestrial communication."

"In English or what?" I was dumbfounded.

"It was in English but also beyond all language. They told me that their associates had been to see Harry Truman when *he* was president. Now remember Dick, he's the one who ordered the atomic bomb to be dropped on Hiroshima and Nagasaki. And yet these creatures convinced him not to turn Korea into another nuclear holocaust. That's really why he brought back General Douglas MacArthur."

Ike stared ahead with a blank expression in his eyes.

"Sir, are you all right?"

"Yes. Yes. I just don't know if I can articulate this extraterrestrial experience. It was as though my body remained in the chair and my spirit was taken on a journey. All I know is that when I returned, I just had to tell the truth. There was no other choice--"

Ike stopped in mid-sentence. He never mentioned that incident again. Nor did I feel it would be proper for me to broach the subject. I

dismissed it from my mind. It would not be until nearly fourteen years later that my *visceral* understanding of his experience would occur.

The year 1974 was so rough on me that for a while I thought I could actually be going insane. I wondered if I was being drugged without my knowledge. I found myself wallowing in paranoid fantasies, and I gave voice to these at press conferences. I expressed the fear that my plane might crash. I resorted to using expressions like "They can point a gun at your head." I was practically begging for mercy.

When I entered Memorial Hospital Medical Center in Long Beach on October 23 for my phlebitis condition, I brought my own jar of wheat germ, because I was afraid that poison would be put in my food.

On October 29, the doctors placed a clamp on a vein in my pelvis in order to prevent the blood clot from moving to my lungs where it could have killed me. It was then that I went into cardiovascular failure.

On October 30, Ron Ziegler announced, "We almost lost President Nixon yesterday afternoon." This was almost three months after my resignation, and he was still referring to me as President. "Poor Ron," I thought to myself. "He thinks he's still in Disneyland."

For a few hours I was considered to be clinically dead. It was an incredibly ecstatic feeling. I was conscious, but on some other plane of

existence, and there was an overwhelming temptation to remain in that blissful limbo. Yet there was also something in me that kept saying "Don't give up!" It was my survival instinct speaking.

But why not give up? What was there left for me? The answer came to me by the same extraterrestrial path it had come to Ike: *Tell the truth!* That was the turning point of my life. And these memoirs are the tangible result of my transformation. No one shall be spared, least of all myself.

Those hairless creatures told me that President John F. Kennedy had also been visited by their kind. His father, old Joe Kennedy, had gotten rich off illegal booze during Prohibition, and you can be certain that the underworld bootleggers he was tied up with were not about to dissolve their silent partnership in this huge liquor industry they had built up, simply because Prohibition had been repealed. Yet there was Joe Kennedy's own son, Jack—not to mention his brother Bobby—refusing to cooperate any longer in allowing organized crime to have a comeback in Cuba, and furthermore, going after organized crime in *this* country. At best this was ingratitude; at worst it was treason.

But I finally understood the extraterrestrial force that had motivated young Kennedy. And so now I am ready to peel away the final layers of my poker-face mask.

For example, I occasionally went too far while wearing my anti-Communist mask. When former Attorney General Nicholas Katzenbach exposed the DuBois Clubs as a Communist front organization, poison-pen letters and threatening telephone calls were received by many of the Boys Clubs from patriotic Americans who were understandably confused by the ostensibly coincidental pronunciations. But in my function as National Board Chairman of the Boys Clubs of America, I charged that the name choice was "an almost classic example of Communist deception and duplicity" and that the W.E.B. DuBois Clubs "are not unaware of the confusion they are causing among our supporters and among many other good citizens."

In retrospect, however, I admit that this was a slightly foolish position to espouse.

* * *

In August of 1945, while I was still serving in the Navy, stationed in Maryland, there was a Committee of 100 seeking—according to an advertisement they placed in several California newspapers—a candidate for Congress "with no previous political experience, to defeat a man who has represented the district in the House for ten years." This was a reference to Jerry Voorhis.

I did not see the ad, but destiny acted as though I had answered it, when I was contacted by Murray Chotiner for Herman Perry, vice president of the Bank of America. Perry later became vice president of the Western Tube Corporation, a CIA front located in the Whittier Bank of America building. But now he wanted to know only if I was a Republican and if I was available.

My responses were both affirmative.

It was Perry who brought me out for an extremely brief meeting with Howard Hughes. Hughes was handsome, dynamic, self-assured. Somehow he had seen the FBI dossier on me, which had apparently been compiled when I applied for a position with the Bureau after graduating law school. Oddly enough, I had never heard back from the FBI directly.

"Nixon," he addressed me, "you have a magnificent political future ahead. You will be able to steer your ship independently. But always keep it in a tiny compartment of your mind that you do not own the ocean. I do."

I never saw Howard Hughes face to face again.

* * *

The seeds of my distrust of the Justice Department were sown in 1948 during the Alger Hiss case. Those people just sat on each other's

hands. If not for the work of our House UnAmerican Activities Committee, the prosecution would never have been so successful.

I refused to turn over to those bunglers the microfilms we had in evidence. When there was a possibility I might be cited for contempt, I raised the point of what a dangerous precedent could be set, since here I was, a U.S. Congressman, appearing voluntarily before a grand jury.

But the truth of the matter was that those microfilms were copies of documents forged on an old Woodstock typewriter that had been specially constructed to resemble—to have the same peculiarities as—the typewriter that had actually belonged to Alger Hiss's wife, Priscilla.

Then Whittaker Chambers hid these "old" 1938 microfilms inside a pumpkin on his pumpkin farm. The trouble was, the Eastman Kodak people stated that the type of film we used was not manufactured by their company until 1945.

To this day, whenever the comic strip *Peanuts* mentions that bird named Woodstock or the mysterious "pumpkin papers," I suspect Charles Schulz is trying to remind me of something.

* * *

There seems to be a tradition of accusing those who fight Communism of being homosexual. This smear tactic was used against

Whittaker Chambers, against Senator Joseph McCarthy and against J. Edgar Hoover. In that vein, gossips used to rant about Hoover and Clyde Tolson double-dating with Charles "Bebe" Rebozo and myself.

Neither Rebozo nor I are "gay." We have been very close friends since 1950. What we enjoy most about each other's company is the fact that small talk becomes unnecessary. We are not afraid of silence. But we have never had any kind of sexual relationship.

We were introduced by Senator George Smathers, who was infamous for supplying female companions to his fellow legislators. It was Smathers who eventually sent Mary Jo Kopechne to be with Senator Edward Kennedy.

Whenever I was in Florida, I would stay with Bebe, and he would occasionally get a couple of beautiful $200-a-night girls. Or as they would be called nowadays, $200-a-night women. But when I bought my own home in Key Biscayne, then his yacht became our rendezvous site.

I was certainly not promiscuous, but I had been a virgin until marriage. I proposed to Pat Ryan the very same night I met her. She refused, but I was a determined son-of-a-gun. I even drove her to Los Angeles when she dated other men while I waited in the wings. I finally charmed her with my perseverance and self-effacement.

Once I express concern to Bebe that word might get out about my "affairs" in Key Biscayne. "These girls," I pointed out, "are likely to brag about going to bed with a United States senator."

"They're professionals," Bebe reassured me. "It's just like your lawyer-client privilege. Stop worrying."

* * *

One evening in 1949, while I was still serving in Congress, I received an anonymous call at my home. A male voice said three words, "Watch Jeane Dixon," and hung up the telephone.

A week later, the psychic Jeane Dixon held a press conference. One of the reporters asked her to predict my future. She drew a blank, however, explaining that she needed time to meditate. I believe that in show business parlance this is known as "milking the audience." Finally she said it: "I predict that one day Richard Nixon will become president of the United States."

I could only conclude that the higher source from which she had received her intelligence was not necessarily supernatural. When I lost the presidential election to John F. Kennedy in 1960, Jeane Dixon *continued* to predict that I would be president. "Destiny," she said, "cannot be denied."

Even after I was defeated in the 1962 California gubernatorial election and announced that I was through with politics, she said, "Richard Nixon has not even *begun* his rise in politics." And then she predicted the assassination of President Kennedy in 1963.

After the Watergate affair, she stated: "God gave us Richard Nixon to divide us, to test us where our faith is concerned, to see if we could come together." A local paper published her statement ("God gave us Nixon to divide us.—Jeane Dixon") as the caption for a cartoon showing a cloud with the voice of God saying, "Don't blame me—I voted for McGovern." I had to admit it was funny, even though she had been quoted out of context.

* * *

Harry Robbins "Bob" Haldeman came into my life when I was a senator in 1951. He volunteered to work on my vice presidential campaign the next year, but that campaign was not to be for him, so he tried again in 1956, and this time we took him on. He rose to be my chief advance man for the presidential race in 1960.

After my defeat, Haldeman remained loyal. He volunteered to help me with my book, *Six Crises*. I wrote the chapter on the 1960 campaign myself because it was so fresh in my mind. Al Moscow drafted four other

chapters with Haldeman—this was not ghostwritten material because I rewrote what they presented—and Haldeman worked mostly on the Alger Hiss chapter.

He was apparently so eager to please, though, that he screwed up on his research. He had it that the FBI found the old Woodstock typewriter. And the book was published that way. Then the facts came out, the trial records and all, and we had to change it for the paperback edition. So now it reads that the FBI was *unable* to find the typewriter.

The truth is, Alger Hiss found it himself. But the FBI had *planted* this fake Woodstock typewriter. And then the *defense* presented it in the trial as what they *assumed* was evidence in their favor. So a least Hiss was found guilty of perjury.

That verdict added immeasurably to my political strength. I had the courage of Alger Hiss' s conviction and it served as the magic carpet that transported me from the Congress to the Senate to the vice presidency. I would have had the presidency in my pocket if not for Kennedy' s performance in the Great Debates—but only on television; I fared better on radio. Kennedy' s charisma was the variable that none of us had counted on.

* * *

How strange that the incident from the entire eight years I spent as Vice President that stands out most prominently in my memory occurred not in the White House but in Peru. There was a rioter who spat on me, and it was with great pleasure that I kicked him in the shins.

Back in the safety of our hotel that night, I recalled an early formal debate at Whittier College— "Resolved: that insects are more beneficial than harmful" —because I had been so intrigued as to how insects did not think, they just acted. Now, having myself acted totally without hesitation, I was able to identify with those insects.

As Vice President, I labored diligently behind the scenes to establish Operation 40, by which our CIA covertly trained Cuban intelligence officers in exile. Operation 40 was to serve as our link between the White House and the CIA in April of 1961. My plan was to invade Cuba.

Ironically, during the 1960 presidential campaign, Kennedy began advocating *my* plan. I could not reveal that it was *already* in effect because Operation 40 was a *secret* project. Further, I found myself in the schizophrenic position of attacking my own idea whenever Kennedy articulated it, because it violated our treaty commitments.

* * *

Of all the professional newscasters I have met, Walter Cronkite of CBS was the most charming. He treated me with respect and dignity. After the broadcast interview, we sat in his anteroom and talked informally.

"I've always wanted to thank you," he said, "for inadvertently bringing me back to sanity that horrible weekend John Kennedy was killed."

"Oh, really—how so?"

"This followed on the heels of the televised shooting of Lee Harvey Oswald by Jack Ruby. A journalist asked for your reaction, and you replied with a slip of the tongue, 'Two rights don't make a wrong.' Before you could correct yourself, I was finally able to break through my depression with a bit of laughter."

"Yes, those were muddled times. Do you know I *forgot* where I was the day the assassination took place? I had to tell the FBI I couldn't remember, and it was not until later that I remembered I had been in Dallas, of all places. There was a convention of the American Bottlers of Carbonated Beverages, and I was there representing Pepsi-Cola. But I flew out of there at eleven o'clock that morning. Kennedy was shot around one o'clock, as I recall. Where were *you* that day?"

"In my office," Cronkite said. "When we got the word from Bethesda that he had passed, I cried openly."

"And you're supposed to be objective," I teased him. "I didn't realize you were that much of a Kennedy supporter."

"Well, by that time I was crying because it had also come over the wires that Lyndon Johnson was already preparing to be sworn in as the new president."

It was encouraging to find that in person this superstar really was just like your favorite uncle.

* * *

When Robert Kennedy was attorney general in 1962, he was busy checking out the Hiss case for some reason. Of course, he discovered that the FBI never had the Woodstock typewriter.

Then, in 1968, when he was running for president, he approached New Orleans District Attorney Jim Garrison to be *his* attorney general. Garrison had gotten a lot of publicity due to his investigation of the assassination of Bobby's brother.

During that campaign, Howard Hughes dispatched Robert Maheu to visit me. Hughes felt strongly that the Vietnam War should continue—he had a huge defense contract for helicopters—yet at the same time he

wanted a halt to underground nuclear testing, presumably because it upset the roulette wheels in his Las Vegas casinos.

I mentioned the Bobby Kennedy information to Maheu, and he said, "Uh-oh, the boss will have to keep a sharper eye on *him*."

It was poetic irony that while Bobby Kennedy was giving official permission to J. Edgar Hoover to spy on Martin Luther King, I was giving unofficial permission to Hoover to spy on *Kennedy*. That is to say, Robert Maheu may have been working for Howard Hughes, but he had also continued working for the FBI. So when he referred to "the boss," I asked, "Which one?"

Maheu smiled and held up his arms, two fingers from each hand extending up into the air. "Both," he said. This was the exact moment I decided to use that gesture for the crowds.

Winston Churchill had used the V-sign to signify Victory. Then the antiwar protesters perverted its meaning to signify Defeat. Now I was restoring its original victorious symbolism by co-opting the co-opters. Or so I believed.

* * *

The problem was that Lyndon Johnson desperately wanted to have the Vietnam War settled before he left office. Whereas, I am ashamed to admit, we were trying to prolong it.

Anna Chennault—the Dragon Lady, as we called her—was our liaison to South Vietnamese government officials. Her task was to dissuade their ambassador to the U.S, Bui Diem, from attending the Paris peace talks.

But LBJ got wise to this. I had to call and cajole him personally. He was absolutely furious. He complained bitterly at how "shit-kickin' pissed off" he was. "Thieu is *our* boy," he shouted, "and don't you fuckin' forget that!"

On November 1, 1968, only four days before the American election, President Nguyen Van Thieu announced that Saigon was pulling out of the peace talks. The Dragon Lady had obviously convinced his associates that they would obtain a juicier deal under our new administration than under Johnson or his chosen successor, Hubert Humphrey, who would surely have won if the Democrats had ended the war.

And so, because it was in the mutual interest of the South Vietnamese and the Republicans to extend the war for several more years,

we became the recipients of kickbacks from our own government' s aid to the Saigon government.

I do not ask for forgiveness. No, rather I must live with the memory of myself as an idealistic adolescent first reading about the Teapot Dome scandal and saying to my mother, while helping her to mash the potatoes, "I would like to become an honest lawyer who can' t be brought by crooks." But my character had already been set. When I was only five years old, my mother intended to buy me a copy of *The Prince and the Pauper*, but she asked a bookstore clerk for *The Prince*, and so of course he gave her Machiavelli' s book. Mo mother was a saint. Her little mistake changed my life, and I will always be grateful for what I feel must have been a touch of divine intervention.

* * *

We created a couple of Frankenstein monsters, and when I say we, I mean the administration and the media in an unintentional collaboration.

One such monster was Martha Mitchell. The first time she made one of her famous telephone calls and we saw how the press ate it up, we realized we had a political gold mine. The wife of the attorney general could serve as our mouthpiece for floating various trial balloons.

John Mitchell would get thoroughly briefed on whatever the issue was—Haiphong Harbor or Senator Fulbright or the need for increased spending—and then, without ever letting Martha know that he *expected* her to give a scoop to some lucky reporter that evening, John would simply smoke his pipe and just happen to engage her in casual conversation about the matter.

Martha was much too strong-willed to be *instructed* to make a call, but she could be counted on to make the call, even if it was three o' clock in the morning when the urge hit her. This was a great joke among the reporters. One little news item quoted her latest pronouncement, and after the quote that sentence was completed with, "Martha Mitchell confided to the *Washington Star* yesterday..." Confided, indeed—to a *newspaper*.

But in the process of becoming a public character, she developed many contacts in the media. By the time her husband became my campaign manager, Martha Mitchell was already a household word. We thought she would prove to be a wonderful asset until she started blabbing about Watergate.

Another Frankenstein monster we created was Henry Kissinger. I never really wanted him in the first place. He had insulted me publicly when I received the nomination in ' 68. But I made an agreement with

Nelson Rockefeller that if he would actively support me, I would take Kissinger onto the team, and of course I had to keep my word.

We all felt somewhat uncomfortable about his German accent. H.R. Haldeman decided that whenever Kissinger made any statement, his picture could be shown on TV but there would be no audio. And the electronic media cooperated.

Meanwhile, we built up his image, got him dates with glamorous movie stars—Jill St. John, Marlo Thomas, Liv Ullmann—until he became known as a harmless, pudgy playboy. Then it was acceptable for his voice to be heard.

"Henry," I once remarked to him, "there's a rumor going around Washington that you're lousy in bed."

"Mr. President"—speaking very slowly and distinctly—"I can only say that . . . *power* . . . is the ultimate aphrodisiac."

And he just kept glaring at me with those worried-looking eyebrows frowning over his spectacles. This was just three days after our destabilization of the Chilean government. Kissinger wanted all the credit, but it was really a team effort.

We could not have succeeded, for example, without the invaluable aid of Teamsters Union President Frank Fitzsimmons and his Bob Hope-

like timing in manipulating the truckers' strike in Chile. It is possible to bring about the collapse of an entire economy by shutting down one integral aspect, especially communications or transportation.

Moreover, the Soviet Union was trying to cut off the United States' supply of a metal vital to jet engine production, by their support of the Allende government in Chile and also by backing guerrilla actions in Angola. In order to maintain the war in Vietnam, we needed Chilean copper as well as the trace metal. At any rate, we were a smooth, well-oiled team, on the way to winning the whole, beautiful, global game.

* * *

In 1968, George Wallace ran for president as the candidate of the American Independent Party. This almost lost me the election to Hubert Humphrey. In 1972, Wallace ran for president again. This almost cost him his life. I honestly have no knowledge as to how long Arthur Bremer was in our employ, but I do know that the cover story of his having stalked me before he went after Wallace was fabricated simply to defuse any suspicion that might have pointed to our role in the tragic event.

After all, my supposed public mandate that November came from a majority that included twenty million votes that would otherwise have gone to George Wallace. We had not expected him to pose so much of a

threat. In fact, we had already taken certain steps to preclude any such possibility. In 1970, immediately after he became governor of Alabama again, the iRS and the Justice Department launched an investigation of Wallace and his brother Gerald for tax evasion and other forms of financial corruption.

I don't fault Wallace for family loyalty, by the way. I have carried out similar filial responsibility to my own brother, Donald. This is only natural.

In any event, John Mitchell, still attorney general at the time, came to me early in 1971 and said, "We've got to stop George Wallace. He could force the election into the House of Representatives if he runs on a third party ticket again."

In May of that year, I was in Mobile and invited Wallace to fly with me on the presidential plane to Birmingham. En route, we shook hands on an agreement. I promised that Mitchell would call off the investigation of Wallace and his brother—although their underlings would still be subject to prosecution—and the governor in turn promised me that if he ran in '72 it would only be as a Democrat.

In August 1971, we discovered that CBS correspondent Daniel Schorr had been asking around about the possibility of such a deal. Haldeman commented, "We'd better get on *his* ass—fast."

Two years later, when Schorr reported that John Dean was afraid of going to prison because he might get raped there, we were able to find out immediately from the FBI that his source was Dean's own attorney, but there was nothing constructive we could do with that information.

However, it must be noted for posterity that John Dean was a closet queen supreme. His lovely wife, Maureen, is merely window dressing. Oh, how neatly she rolled up her blond tresses into a perfect bun and sat behind him at the Watergate hearings every day, blatantly projecting a modern-day American Gothic image. I recall how it came out that Dean had taken almost $5,000 from a White House safe for a hurried honeymoon right smack in the middle of the cover-up, He was already disguising his tracks. Their marriage was purely protective coloration.

The case of John Dean does raise the question, when is a so-called leak actually convenient propaganda?

Maureen Dean was an on airplane flight when she "accidentally" dropped her purse and spilled a vial of amyl nitrate capsules on the floor. She explained to the man sitting net to her how wonderful these were for

enhancing her sex life with John. Is it not possible that this lady was protesting just a mite too much, particularly to someone who would just happen to let the media in on her secret?

No wonder G. Gordon Liddy said that John Dean was qualified to sing the title role in *Der Rosenkavalier*—because it is sung by a woman. Liddy once made a remark in German that I asked him to translate for me. He said, "John Dean's priorities are all screwed up. He doesn't know whether he wants to go down in history or down on a historian."

* * *

Young people might use the expression "karma returning" to describe a deal we made with Jack Anderson, who had himself exposed the corruption of so many others in his syndicated column for the *Washington Post*.

We were tipped off that Anderson was researching the Dragon Lady connection. He had learned that her late husband, General Claire Chennault, who had commended the Flying Tigers in World War II, had in 1946 formed a private commercial airline that later merged with the CIA's Air America.

He also learned that our Dragon Lady was currently profiting from a Pepsi-Cola factory I had established in Laos, but which had never spewed

forth a single drop of Pepsi. Air America had been shuttling out its *actual* product: heroin.

However, Anderson agreed not to publish this material. In return, we agreed not to publicize the fact that he knew about the Watergate break-in weeks before it occurred. He had warned Lawrence O' Brien at Democratic National Committee headquarters, but O' Brien remained silent because he assumed that such a scandal would provide ammunition for a Democrat *coup* in the ' 72 election. He overestimated public outrage.

Anderson held back because he did not wish to endanger his source, one of the "burglars," Frank Sturgis, whom he had known for some twenty years. Shortly after my resignation in 1974, I received a long letter from Sturgis. I shall quote here a portion of that correspondence:

Now, I' m telling you this because I still consider you my Commander in Chief. I realize that the same faction of the CIA that masterminded the assassination of Kennedy was also behind your downfall. They thought JFK was soft on Communism in Cuba, and that you were soft on Communism in China, but that they didn' t necessarily have to kill you to get rid of you.

While I participated in Operation 40, our job was primarily to infiltrate foreign countries. I was a member of the Assassination Section. Orders would filter down, and our job would be to kill, say, a military official or a politician. Even in those days, unstated policy included domestic as well as foreign enemies.

But I had nothing to do with the Kennedy assassination myself. The FBI came to interview me the day after it happened, and I didn' t have a thing

to tell them, except that I could agree with their speculation that the motive was revenge for the Bay of Pigs failure. There's no doubt in my mind that if you had been elected in 1960, the invasion would have been completely successful.

For a while I believed that Bernard Barker was the double agent in Watergate, but I have since come to the conclusion that our leader, James McCord, was guided to do the things he did by certain officials in the CIA. We were definitely set up. They used us to eventually destroy the office of the presidency. You were just as expendable as Kennedy.

I shouldn't have been surprised Mr. McCord was our Security Chief. I myself, as an infiltrator of Castro's inner circle, rose to Director of Security for the Cuban Air Force and Director of Intelligence. Who can you trust?

Whereas I agree with Frank Sturgis that the Watergate burglars were "set up," I question the reason he gives. The CIA was fully aware that relations with the People's Republic of China were bound to open up sooner or later. And of course I wanted to earn credit for that in history.

Rather, I am convinced that there was a power struggle *within* the Agency. The "faction" to which Sturgis alludes—most likely led by CIA's Richard Helms—was jealous of the Special Intelligence Unit we had developed inside the White House.

* * *

Not only was the Watergate break-in deliberately bungled in order to discredit me, but the White House taping system was never part of my domain. I knew it had been installed by the Secret Service, but I lacked

access to the tapes and, more important, to any switch that would shut off a recording device.

I was a prisoner in the Oval Office. A mobile prisoner, to be sure—I could go to the Cabinet Room or the Lincoln Room—but it didn't make any difference; there were bugs everywhere. They even bugged my cabin at Camp David. I was under more surveillance than Larry O'Brien could ever imagine.

If I had the tapes in my possession, don't you think I would have gotten rid of them? Just the way I did with those microfilms in the Hiss case. Everybody was recommending this—from John Connally to Chuck Colson—but I simply did not have access to the system.

I should explain that "Bay of Pigs" was our code word for the assassination of President Kennedy. When we were attempting to put the brakes on the FBI investigation of Watergate, I told Haldeman to get word to Helms that otherwise, because of E. Howard Hunt's involvement, the whole Bay of Pigs thing would open up.

Hunt was the CIA station chief in Mexico when agent Lee Harvey Oswald made contact there in 1963. The whole world already knows what a fiasco the Bay of Pigs operation turned out to be—that is, the invasion of

Cuba—but because Kennedy didn't keep his campaign promise to support the exiles, he then became the prime "Bay of Pigs" target.

Had the Watergate mission not been aborted, Hunt would have continued to simulate documents blaming Kennedy and Ted Sorensen for the murder of Che Guevara, just as he forged those cables blaming Kennedy for the murder of Ngo Dinh Diem.

I hasten to add that Hunt was merely *clarifying* the issues. The Kennedy Administration was responsible. But what we were trying to do was hurt *Ted* Kennedy's chances if he decided to run. However, that is guilt by relationship, which is wrong and irrelevant.

* * *

I was convinced that Nelson Rockefeller was behind it all. He had never forgiven me for defeating him for the Republican nomination in 1968. What with that whole 25th Amendment arrangement, I figured their chronological plan was to:

1. Get Spiro Agnew out of office.
2. Replace him with Gerald Ford.
3. Get me out of office.
4. Replace me with Ford.
5. Replace Ford (as vice president) with Rockefeller.

6. Knock off Ford before the election by Squeaky Fromme, Sara Jane Moore, whoever.

7. Replace Ford again with Rockefeller, declare martial law and cancel the election. Alternatively, this could be done by killing Jimmy Carter before the inauguration.

Now I realize how naïve I was. Granted, Carter is more progressive than I am—after all, politics is the art of finding a balance between the status quo and the force of evolution—but it became crystal clear to me that he had made some kind of deal. The intelligence-gathering system knew about G. Harrold Carswell's tragic gay problem. Now, *he* would have been a fine prospect for blackmail: "We have this photo of you and a friend in the men's room, Justice Carswell, but don't worry, we won't leak it." I wonder, if I had been successful in appointing him to the Supreme Court, how would he have voted on the constitutionality of entrapping homosexuals? Anyway, my suspicions were aroused when it did not come out in the media until *after* the election—immediately before Carter's inauguration when it was too late to do us any good—that his son Jack had been discharged from the Navy because of marijuana.

Our hammer over George McGovern's head in 1972 was that his daughter had been hospitalized for an LSD freakout. We never had to resort to using that particular bit of intelligence, however, despite the fact that it was *we* who had arranged for her to be "dosed" in the first place.

* * *

Woodward and Bernstein were not the only ones with reliable sources. According to one of my contacts in the intelligence community, the Democrats' first choice for a presidential candidate in the 1976 elections was a southern governor—Askew of Florida—but their analysts calculated that Jimmy Carter's resemblance to Howdy Doody would provide a subconscious association in the minds of voters who were weaned on that folksy puppet.

What the American public does not realize is the impact of the long-range planning that goes on in think tanks such as Stanford Research, the Rand Corporation and the Hudson Institute. They are already beginning to orchestrate the Bimillennium, the 2000th birthday of Christ. The function of Jimmy Carter—with all his religiosity and his talk about not living in sin—is to provide an opening wedge for the Christianization of the United States. The arms manufacturers would be well pleased by a repeat performance of the Crusades. After those Korean bribes via Reverend Moon's Unification Church and the brainwashing of the Moonies, they'll finally figure it's time to make Christ an *American* again.

Incidentally, Billy Graham recently tried to convert me, the same way he did with that professional gangster, Mickey Cohen. "Think what it

would be like," he sad, "if you were to go on an evangelistic tour with Eldridge Cleaver and Colonel Sanders."

"You mean the Kentucky Fried Chicken guy?"

"Yes, he has been born again too."

"No, thank you, Billy, I seem to have found serenity in my own way."

I truly have been able to gain real humility now that Chuck Colson and Susan Atkins are saying the same things about Jesus Christ that they were once saying about myself and Charles Manson, respectively.

* * *

History is an unending conveyor belt that either perpetuates or corrects the inaccuracies of the past.

Therefore, the first thing I wish to point out, concerning that infamous eighteen-and-a-half-minutes gap in the White House tape of June 20, 1972, is that it actually lasted only eighteen-and-a-quarter-minutes. At 10:30 that morning, John Ehrlichman was in my office. We did not discuss Watergate. Before leaving, however, he handed me two sealed envelopes. One contained a gram of cocaine; the other contained a preliminary report on the surveillance of Woodward and Bernstein. This

task had been assigned to Tony Ulasewicz immediately after their first story on the break-in was published in the *Washington Post*.

It was strange. Ehrlichman's own first assignment had been to spy on the Nelson Rockefeller people for us during the 1960 campaign, and now he had his own chain of command. I have noticed that Ehrlichman's brow has become more knitted as he has advanced in his career. When he left, I opened the sealed envelope and read the report. It was brief:

Bernstein, Carl: Heavy pot smoker. Living apart from his wife. Began affair with Nora Ephron, Esquire *columnist, in New York while her husband, Dan Greenburg, book author, was at EST, Erhard Seminar Training.*

Woodward, Bob: A loner. Clean as a hound's tooth. So far.

Then I began to "chop the coke," as they say, with a razor blade. When Bob Haldeman entered, we each took a couple of snorts. Haldeman was my Sherman Adams. I had always felt I could depend on him. We were discussing whether my itinerary for an upcoming trip to the West Coast might include Ely, Nevada, which was the birthplace of Mrs. Nixon,

"That's perfect," Haldeman said. "We need anything we can get, PR-wise."

"But you know something, Bob? It's all image."

"Well, that is precisely the *purpose* of public relations."

"No, I mean my so-called marriage is all image. Pat and I have not, you know, slept together for many years. My God, I was the President of the Unites States, and I couldn' t even get laid by my own wife."

"Sir, you don' t really want to talk about this--"

"And I' ll tell you where it started. During the Cuban Crisis in October ' 62. Boy, Kennedy sure won a helluva lot of points on that one. And it could' ve been *me* confronting Khrushchev. I mean a real international shootdown, not just waving my finger at him in Safire' s goddamn makeshift kitchen."

"That would have been the logical extension of your Russian trip."

"I tell you, the unspeakable frustration of not being in a position to negotiate that missile thing. I just couldn' t get it up for Pat, plus the pressure of the California campaign was going on then too. And after we lost that election, she started talking about a divorce. We compromised with separate bedrooms."

Suddenly I stood up, walked around my desk to where Haldeman was sitting, and I ran my hand back and forth across the top of his crewcut. I am not very physically demonstrative, but I had always wanted to do that. Still, this was almost a spontaneous gesture.

"You stuck by me, Bob," I said while I rubbing his hair. "Finch dropped out, but you . . . " And I began weeping uncontrollably.

"Sir, is there anything I can do?"

Between sobs I blurted out, "Oh, sure" —I certainly did not intend for this to be taken literally— "Why don't you try sucking my cock, maybe *that'll* help."

To my utter astonishment, Haldeman unzipped my fly and proceeded with what can only be described as extreme efficiency. The whole thing could not have taken more than five minutes from beginning to end. He must have had some practice during his old prep-school days. Neither of us said a word—before, during or after.

This misunderstanding was comparable to the time that Jeb Magruder remarked how convenient it would be if we could get rid of Jack Anderson, and G. Gordon Liddy assumed that was a direct order and rushed out to accomplish the act. If Liddy had not blabbed his "assignment" to an aide in the corridor, Anderson might not be alive today.

As for my own motivation, here was an experience not of homosexuality but of power. I realized that if I could order the Pentagon to bomb Cambodia, it was of no great consequence that I was now merely

permitting my chief of staff to perform fellatio on me. In fact, I was fully cognizant of what an honor it must have been for him.

When the incident was over, I simply returned to my desk, and although the tension of vulnerability was still in the air, we resumed our discussion as if nothing had occurred.

"Now," I said in a normal tone of voice, "what's on the agenda?"

"Sir," Haldeman began, "on this Watergate problem, it would be advantageous to us if any similar activity on the part of the Democrats could be leaked to the media."

"Well, Hoover once told me—this was right after we won in '68—he said that within the previous month, LBJ had the FBI put the bug on Agnew and me. Ramsey Clark was attorney general then, but he never authorized it, so that was an *illegal* wiretap."

"Perfect. We start with Lyndon Johnson and work our way back."

"But no, on second thought, the LBJ tap would open up the whole Dragon Lady can of beans. I mean that was the goddamn *excuse* they had for spying on us."

Then Haldeman delivered a resounding pep talk—when he lets loose he can be an emotional marvel—about the importance of launching a counterattack against our enemies.

I must say at this point that Rose Mary Woods deserves a Medal of Honor for the way she was willing to humiliate herself by taking full blame for accidentally erasing those first five minutes rather than stand by while my public image was being destroyed.

Moreover, when General Alexander Haig learned from Haldeman's notes that during those additional thirteen-and-a-quarter-minutes there was a discussion of how to deal with Watergate, thereby proving that I was involved in the cover-up only three days after the break-in, Haig attributed the erasure to "sinister forces." He said this under oath in Judge John Sirica's courtroom.

Now *that* is loyalty above and beyond the call of duty.

* * *

In retrospect, I realize that H.R. Haldeman was part of the plot against me all along, always trying to ingratiate himself—anything to impress me, when actually he w as trying to hurt my political career. Not that he was against me personally; I was just his particular assignment as

part of an overall plan "to destroy," in the words of Frank Sturgis, "the office of the presidency."

Haldeman was a saboteur in the guise of a sycophant. In 1967, when he was a vice president at the J. Walter Thompson advertising agency, he sent me a long memo on how I could use the media in my '68 campaign. I have since learned that during World War II, various corporations—Standard Oil, Wrigley Chewing Gum, Paramount Pictures—lent their services to the Office of Strategic Services, which later became the CIA. The Thompson Agency supplied Kenneth Hinks to be chief of the OSS planning staff. One of Haldeman's predecessors, Richard de Rochemont, a vice president of J. Walter Thompson, was offered a position with the Secret Intelligence Branch of the OSS. Another Thompson official, Donald Coster, stayed on with the CIA in South Vietnam from 1959 to 1962.

That's when Haldeman really latched on to me, in the '62 campaign. And when we lost, it was Haldeman who persuaded me to make a public fool of myself with that godawful "You won't have Nixon to kick around any more" press conference. It was Haldeman in 1972 who acted as a double agent and conspired with Dick Tuck to have all those Chinese fortune cookies contain the same message: "What about the

Howard Hughes loan?" And it was Haldeman who consciously sabotaged the research on the Hiss chapter in *Six Crises*.

On one occasion I was meeting with a group of blind veterans in the Oval Office. I wanted to display my empathy with them, so I began describing the Presidential Seal, which was woven into the carpet we happened to be standing on. A blind veteran got down on his knees and started feeling that design with his hands. I closed my eyes and proceeded to do the same. It was perhaps the most spontaneous gesture of my life, although I must admit I was grateful to hear the sound of cameras whirring. I was pleased that this scene of my true humanity was being recorded for posterity. But Haldeman ordered an embargo on that photograph, ostensibly to protect the dignity of my image, because the president should never be seen in a kneeling position.

Even a year after he resigned, there he was, old faithful Bob Haldeman, backstage with me at the Grand Ole Opry in Nashville. He chided Johnny Cash for that time he refused to sing "Welfare Cadillac" at the White House, and Cash now replied, "Should I do it tonight and dedicate the song to you now that *you're* on welfare?"

Haldeman did not appreciate the humor in that. He was too preoccupied with the betrayal of me that he had in mind. He handed me a

yellow yo-yo and said, "This will really please the crowd. It's an official Roy Acuff model." I put the yo-yo in my pocket. Haldeman did not mention that the string had been loosened at the bottom, so when I was onstage and I flung that yo-yo down, it just *stayed* there. Once again, Haldeman had transformed the president into an asshole.

It was Haldeman who had urged me to Install the White House taping system. It was Haldeman who hired Alexander Butterfield, who testified to the whole world about the tapes, and told the FBI about E. Howard Hunt. Butterfield brought in Al Wong to set up the system and check it every day. And it was Wong who brought James McCord onto the team. It all seems so obvious now.

One thing about Gerald Ford, though: He keeps his promises—not only to pardon me, but also his promise to fire Alexander Butterfield, even though Ford was actually grateful to him. As for me, I should have listened to L. Patrick Gray when he warned me, "People on your staff are trying to mortally wound you."

My wife, Pat, has sworn to me that she never told anyone about our marital difficulties, and of course I believe her, so the leak to Woodward and Bernstein could *only* have come from Haldeman. On top of all his other betrayals, he must have been Deep Throat too.

* * *

There was one plan of the White House Plumbers that never came to fruition. It involved the theft of Patricia Ellsberg's dental records. This was my own idea—not Haldeman's, not Hunt's, not Liddy's—*they* were satisfied with obtaining the records of Daniel Ellsberg's psychiatrist.

But I remembered that the first time Alger Hiss confronted Whittaker Chambers, he requested to see his *teeth*. Hiss explained to me that he suspected Chambers might be someone he had known years before, and he wanted to see his teeth to make sure.

Well, that recollection inspired me. We were able to obtain the dental records of Ellsberg's wife, all right, but did not have the opportunity to use them in helping to prove that she was guilty of espionage. I could not imagine exactly how we were going to achieve this but I did know that, *whatever*, it would be accepted by the public simply because the charge itself was so "off the wall."

How odd that Whittaker Chambers, the dignified translator of *Bambi*, had been asked to publicly show his teeth as if he were some kind of stud at a horse show. I have never been able to forget that moment.

* * *

The paradox of our nation is that we turn our vices into virtues. As the truth about political assassinations—from Malcolm X to Mrs. Dorothy Hunt—finally begins to emerge, we may truthfully say, "Only in America does there exist the freedom to reveal how insidious we have been, and then to continue in our insidious way with an even more determined spirit."

I still believe that the United States is the greatest country in the world. It is also the greatest show on earth.

I once had a vision of myself leaving Washington the way Jimmy Durante used to end his TV program, standing in a spotlight and bowing gracefully to the audience, then walking back a few steps into another spotlight, bowing again, and so on. Instead, I ended up sounding as helpless as Hal the Computer in the movie *2001*, unable to control my own memory banks.

My consolation for this personal tragedy is summed up in Jeane Dixon's prediction: "Historians yet unborn are going to take the facts, and Richard Nixon will go down as a great President. They're going to find that the price the world is paying for trying to discredit Nixon is going to be that we'll practically lose our freedom."

In the meantime, I am, at long last, completely at peace with myself. It has been worth all the struggle.

Postscript:

After "A Sneak Preview of Richard Nixon's Memoirs" was published, syndicated columnist Liz Smith—who hadn't seen that piece—wrote that H.R. Haldeman had been in the Oval Office with Nixon, and that his trousers were down to his ankles. Hoping to smoke out the truth, I retyped one page of the manuscript, inserting a phrase (shown in italics) in this sentence: "When the incident was over, I simply returned to my desk, and although the tension of vulnerability was still in the air *and my trousers were still around my ankles*, we resumed our discussion as if nothing had occurred." I then photocopied the manuscript and sent it to Liz Smith. I had assumed she would check with her source. Instead, she wrote in her column that she had been fooled by *me*, implying that her source had based that revelation on my article. Somehow my hoax on Liz Smith backfired. I had become a victim of my own satirical prophecy.

In his memoirs, I had Nixon insisting that Watergate was a setup to get rid of him as president. A decade later, Nixon himself made that claim in a network television interview. Furthermore, Haldeman in his book, *The Ends of Power*, would reveal that Nixon used code words when talking

about the murder of President Kennedy. Haldeman said that Nixon always referred to the assassination as "the Bay of Pigs." And, on May 5, 1977, the *Houston Post* published a UPI dispatch that stated:

"Watergate burglar Frank Sturgis said Wednesday that the CIA planned the break-in because high officials felt Richard Nixon was becoming too powerful and was overly interested in the assassination of John Kennedy . . . 'Several times the President asked CIA director Richard Helms for the files on the Kennedy assassination, but Helms refused to give them to him, refused a direct order from the President,' Sturgis said. 'I believe Nixon would have uncovered the true facts in the assassination of President Kennedy and that would have taken off the heat in Watergate. Because Nixon wanted files, the CIA felt they had to get rid of him.' Asked if Nixon ever was in danger, Sturgis replied, 'Yes, absolutely. Nixon was lucky he wasn't killed—assassinated like President Kennedy.' "

One other thing. "A Sneak Preview of Richard Nixon's Memoir" was originally published in 1976, in which Nixon insisted that Watergate was a set-up to get rid of him as president. About a decade later, Tricky Dick made that exact same claim on a network television interview.

Satirical prophecy in action.

Why I Leaked the Anita Hill Affidavit

I shall identify myself only as a female aide to a Republican senator. It is also relevant that I have long nurtured a keen interest in psycho-history, the process by which a nation's direction is interpreted as an extension of the psychological makeup of those individuals who govern it.

Without going into specific detail, let me simply state that on October 5, 1991, I happened to hear part of a conversation among Judge—now Supreme Court Justice—Clarence Thomas, Senator Orrin Hatch and Senator Alan Simpson. The three were meeting informally one week after the Judiciary Committee voted, first 7-7, then 13-1, to recommend the confirmation of Judge Thomas, and one day after the full Senate indicated that he *would* be confirmed.

The conversation I happened to hear had to do with those charges brought by Anita Hill and ignored by the members of the committee, both Democratic and Republican. At that point in time I still thought this was an appropriate response, because the alternative would have been to hold an executive session, and Judge Thomas would then have had no practical choice but to resort to heavy denial. Now, however, these men were, in a

jocular fashion, acknowledging the truth of what would turn out to be Professor Hill's allegations.

Senator Simpson was saying, "Y' know, Clarence, I've seen some pretty raunchy porno movies in my time, but I never did see one where a lady was having sex with an *animal*."

"I'll never forget it," Judge Thomas replied in his riveting sonorous tone. "They were in a barn. Except that the inside of the barn was like a theater."

Senator Hatch interjected, "Summer stock, eh? No pun intended"

"There was a stage at one end," Judge Thomas continued his description, "and the stage was facing rows and rows of wooden folding chairs. There were haystacks piled up on the stage, and in front of the haystacks there was a beautiful, buxom, blond woman—and a donkey. Well, the woman began disrobing and she started stroking the donkey to arousal."

"Doesn't sound at all sleazy to me," Senator Simpson said.

"Actually, it had Beethoven piano sonatas playing in the background," Judge Thomas said. "Well, when the woman was fully disrobed and the donkey was fully aroused, they began copulating, right there in front of those haystacks on the stage of that barn. Slow and

sensual. Then bumping and grinding away, accompanied by passionate moans and wild braying. You've never seen a sight like this, I promise. And then the camera panned slowly toward the audience . . . and the audience consisted entirely of *donkeys*."

The Senate office shook with raucous laughter, especially that of Judge Thomas. His booming guffaws rang like huge gongs in a church belfry. And, I must admit, I had to suppress my own laughter. I had been totally caught by surprise, but I appreciated getting the insight. Homo sapiens is, in reality, the only species that has a need for pornography.

When the group's laughter finally began to simmer down, Senator Hatch said, "I suppose that movie was one of the demands of the animal rights people."

"That's correct," Senator Simpson added. "Saving animals' lives is no longer enough. They need *culture*."

I felt like I was imprisoned in the boys' locker room, but I was getting ready to force myself to leave anyway, and it would have ended right there for me if the subject matter hadn't returned to Anita Hill.

"I'm glad nobody considered calling *her* to testify against me, even for a closed-door session," Judge Thomas said. "But you fellas will really love this. Anita Hill was a very opinionated young lady. Actually, she

and I once had an *extremely* animated discussion on the decriminalization of abortion. Can you imagine what the Democrats would've done with *that*?"

And that was the precise instant I made the decision to leak Professor Hill's statement to the press. Although I have constantly been sexually *hassled*, I have never really been harassed in the *legal* sense of the word. However, I *have* had an abortion, and I was totally outraged by the blatant hypocrisy I'd overheard. I had never leaked a document before, but my anger overshadowed my fear.

I chose Nina Totenberg because I had come to trust her reporting about the Supreme Court on National Public Radio. I honestly had no idea what leaking the affidavit would accomplish. I certainly did not envision that it would literally embarrass the Senate into delaying the vote until public hearings were held, though that probably was my secret desire.

But Judge Thomas *testified under oath* that he had never discussed the subject of abortion. However, in response to a question by Senator Hank Brown, Professor Hill testified that she had disagreed with Judge Thomas in a discussion about *Roe v. Wade*. Unfortunately, then-Senator Joseph Biden quickly interrupted her.

"That is not the subject of these hearings," he said.

Personally, I feel quite disappointed about that particular aspect of the testimony, but I have not the slightest regret over leaking Anita Hill's affidavit, and I would gladly do it all over again.

I certainly set a higher moral standard for myself than did the staffer for Senator John Danforth who wrote Judge Thomas's statement that began, "Nobody helped me with this."

President Clinton's Private Confession

The following is a leaked transcript of a closed-door, secretly taped prayer breakfast that Bill Clinton hosted for a group of religious leaders after the impeachment trial failed to remove him from office.

#

Gentlemen--and lady (I guess you must be the Episcopalian)—thank you for being here. It's too bad Reverend Moon isn't among us this morning, so he could perform a mass impeachment of all the senators who swore under oath that they would be impartial. But seriously, folks, I'd like begin with an epiphany I had yesterday, one that truly humbled me. Strangely enough, it happened while I was watching *The Roseanne Show*. I had never seen it before, but she was interviewing Paula Jones and, as my mother used to say, curiosity got the best of me.

Ms. Jones was telling Roseanne about the first time she saw me in that hotel. She was working at the courtesy booth for the governors' conference. She described me as funny-looking, the way my hair was styled, being overweight, how my suit was out of fashion and didn't fit. So, she was sitting at the registration desk with her girlfriend, pointing at

me and giggling. Somehow, I perceived her through the filter of arrogance that people with power develop, and I assumed that she was giving me a come-hither look. That simple misperception is what triggered this whole long ordeal. I took her willingness for granted.

It was different with Monica Lewinsky. I mean to say, she flashed the strap of her thong underwear—it made my heart go *thump*—and, you know, I'm a prisoner at the White House. I can't go to a motel, but Monica appeared like a gift from Heaven, and I succumbed to temptation. I was fully cognizant that this was a very delicate situation—I even asked for *permission* to kiss her—yet I blocked out my foresight. Way back in college, when I tried to avoid military service, I was already thinking ahead to campaigning for president, but now I found myself ignoring the likelihood that Monica would not keep our relationship a secret.

I certainly didn't consider the possibility that she would become so seriously involved with me. It was embarrassing to hear the tape that Linda Tripp made, where Monica told her what she had said to me on the phone: "I love you, Butthead." I remember thinking when it happened, "Hey, I'm the president of the United States, you can't call me Butthead." However, I immediately decided to treat the situation with humor. But she hung up before I could say, "I love you, Beavis."

Surprisingly, I was *not* embarrassed about the infamous cigar incident. I felt that it had been an act of restraint from *actual* intercourse. Kind of tender and playful. Now, if it had been a Cuban cigar, *that* would have been illegal. But this was not the sort of intimacy that I would have felt comfortable performing with the First Lady. Hillary and I are really close, but as I' m sure you understand, no cigar.

For her, the most revealing thing in *The Starr Report* is Monica' s fantasy about our—Monica and me—being together more often when I' ll be out of office; where she quotes me as saying, "I might be alone in three years." Hillary was furious, not only because it had provided a young intern with false encouragement, but also because it implied that we--Hillary and me--don' t have sex, and she felt it divulged our agreement that if we were to separate, it would not occur before we left the White House.

For me, the most revealing section—in that same section of the report—is Monica' s testimony that I jokingly said, "Well, what are we going to do when I' m seventy-five and I have to pee twenty-five times a day?" True, I did say that, but I really *wasn' t* joking. In fact, it was my fear of old age that kept drawing me to Monica. She was my direct link to youth. So I was being *literal* about peeing twenty-five times a day when

I′ m seventy-five. Hell, I drink at least eight glasses of water a day *now*—just like I′ m supposed to, for my health—but then I have to *pee* at least eight times a day. Ironically, the TV commercials warn that if you have to pee eight times in 24 hours, it′ s a symptom of an overactive bladder.

Indeed, irony has permeated this long-running scandal, beginning to end. It was ironic that my sexual appetite helped put me in office—the Gennifer Flowers allegation originally placed me in the media spotlight—and it was my sexual appetite that almost tossed me out of that same office. And it′ s ironic that, although Kathleen Willey *enjoyed* our brief encounter, to prove it we would have had to resort to obtaining testimony from her confidant, the wonderful Linda Tripp.

Now, there are things that I′ ve done as president of which I′ m *truly* ashamed. Even before my inauguration, I made it a point to stop in Arkansas to oversee the execution of a mentally retarded prisoner. At his last meal, he said he′ d wait to have his dessert, a slice of pecan pie, until after the execution—that′ s how much he understood what was going on. I′ m ashamed of *under*-protecting the rights of gays and *over*-protecting children from the Internet. I′ m ashamed of being *against* medical marijuana and *for* requiring a urine test as a prerequisite to obtaining a driver′ s license. I′ m ashamed of bombing Iraq, Afghanistan and Sudan.

I' m ashamed of *in*creasing the military budget and *de*creasing the welfare budget. I' m ashamed of dropping cluster bombs and continuing to plant land mines.

But the Republicans didn' t dare attack me for any of those positions because they are *their* positions too.

I' ll tell you how I survived this past year, how I maintained such high approval ratings, while Newt Gingrich fell by the wayside. How I managed, in short, to remain president. It was partly the state of the economy, and it was partly the state of the culture. Pornography is a twenty-billion-dollars-a-year business in this country. Steven Spielberg told me that' s more than Hollywood' s entire domestic box-office receipts. Because it' s what the American public *wants*. And the TV networks exploit that dirty little secret. It' s why sweeps weeks are always so raunchy. So, then, what *I* did wasn' t considered such a big deal after all.

Mainly, though, I have survived because, one sunny afternoon, Monica was positioning herself on the carpet under my desk in the Oval Office *while* I was on the phone with Benjamin Netanyahu. I was telling him about the time that Monica was performing oral sex on me while Yassir Arafat was waiting in the Rose Garden for our appointment. I

didn't tell Netanyahu that she was just about to perform the same act on me while I was on the phone with *him*. Anyway, at that point, Monica found a big old dusty Mason jar under my desk. There was a label on the side which read, "Property of Ronald Reagan."

That Mason jar was filled with Teflon, and I have rubbed it on myself every day since.

I began my talk this morning with an epiphany, and I'd like to end with another. This epiphany also occurred while I was watching television—*Larry King Live*—and, once again, Paula Jones was the guest. At one point she said, "I've never voted in my life." And I was astounded. Then she said, "I'm so apolitical, it's unreal." And I realized what an incredibly great country America really is, that somebody who was just a plain citizen, who was never even *interested* in politics—somebody who had never even *voted* for a president—had nearly succeeded in toppling one.

Well, this has been a catharsis for me. I just want to say once more how much I appreciate your presence here. And finally I would like to share with you a little witticism that Hillary came up with last night, an idea for what my epitaph should be: "Here lies Bill Clinton, but that depends on what you mean by lies." Isn't she wonderful?

Oh, and one more thing. Now listen carefully. I did *not* have sexual assault with that woman, Ms. Broaddrick. I' ll be honest with you, it may have been *rough* sex, but it was totally consensual. That, I can guarantee. Thank you and God bless you all.

The Autobiography of Monica Lewinsky

The following is an exclusive excerpt from an autobiography-in-progressy by Monica Lewinsky, titled Going Down in History. *The manuscript was leaked to* The Realist *by, of course, a reliable source.*

#

I am not an airhead. I'm a victim, partly of my own making. And mostly, I'm a political pawn of the spin doctors. There are several books being written about the White House scandal, but only a few individuals know what really happened, and only I know who *I* really am, which is why I have decided to write this book. I would write it even if I didn't need the money for legal expenses. My life may be ruined—at least my reputation will be forever tainted—but the truth must be told.

I don't like being a one-dimensional symbol. If anybody were to take a free-association test, the psychiatrist would say "Monica Lewinsky" and the patient would immediately respond "Oral sex." Maybe soon my name will be in a crossword puzzle—the clue: eight letters across—and the correct word will be "fellatio."

Back home in Brentwood, I've been listening to talk radio a lot. Ronn Owens on KABC had listeners phone in with nothing but jokes about me for a solid hour. First he warned the audience that if they were easily offended, they should tune out. I have never felt so objectified in my life, and yet, at the same time, I found the program quite riveting.

The best call came from a nine-year-old who said, "Bill Clinton violated the Eleventh Commandment: Thou shalt not put thy rod in thy staff." The worst call came from a man who asked, "What do the Titanic and Monica Lewinsky have in common?" The answer was, "They both have dead seamen (semen) floating in the hull."

And remember that awful piece of gossip—the one Lucianne Goldberg initiated in order to get attention from the press for *her*—that I kept a blue dress stained with Clinton's dried ejaculation as a souvenir? Well, Jonathan Brandmeier on KLSX invited listeners to call in and suggest euphemisms for presidential semen. My favorite was "Bubba butter." Apparently, my role is to serve as a vehicle for the destruction of taboos.

I have also become an automatic comedy reference. So, to Jay Leno, David Letterman and Conan O'Brien, I'm very useful in punchlines. To *Saturday Night Live*, I'm just a character in their sketches, and never without that beret from my famous hugging-Bill TV footage. But I did

think it was hilarious to cast John Goodman in drag as Linda Tripp. That cheered me up. I' ve been simultaneously depressed, scared and, strangely enough, exhilarated.

As an instant celebrity, I' ve learned that everybody always sees everybody else through their own particular filters. Democrats, Republicans, men, women, the other interns—all perceive me subjectively. For a manufacturer of novelty items, I was simply a disembodied inspiration for the marketing of "Presidential Kneepads." And for *Penthouse* magazine, I would only be considered their next notorious masturbation enhancer.

In the eyes of the media—from NBC News to *Nightline*, from *TIME* magazine to *People*, from the *New York Times* to the *National Enquirer,* from the *Washington Post* to *Entertainment Tonight*—I am purely a commodity. Naturally, I believe in the First Amendment, so I' m against censorship. All I' m saying is that while America is achieving adolescence publicly, the tabloids have won the war.

The battleground is like an ongoing contemporary Shakespearean tragicomedy, but there is no script, there is no producer, there is no director. There is only the process of everyone' s karma interacting. I recall

the words of Terence McKenna when he was a guest lecturer at Lewis & Clark. He said, "Chaos is the tail that wags the dog."

Damage control is the name of the game. It was Dick Morris who advised Clinton to get a dog. Buddy, huh? They should've named him Photo-Op. It was also Dick Morris who suggested taping that ostensibly candid scene of the First Couple dancing on the beach. And I would bet my entire book advance that both Hillary and Bill *knew ahead of time* that Dick Morris was going to release a trial balloon that *if* the rumor about Hillary being a lesbian were true, *then* it would be perfectly reasonable that her husband would need to seek sexual gratification elsewhere.

In fact, the reason I think that Clinton's approval ratings have been so high is because people can *identify* with him fooling around. I mean, when Jimmy Carter admitted that he had lust in his heart, it was the adultery vote that helped get him elected. And that was only lust in his *heart.* Bill Clinton is an *activist.*

I've been reading a book, *Spin Cycle* by Howard Kurtz, and there's a story in there about that time in 1996 when the president said that he "might like to date" a shapely, 500-year-old mummy whose remains were on display at the National Geographic Society. Later, chatting after a few cocktails, Press Secretary Mike McCurry told a dozen

journalists on the press plane that he could understand Clinton's remark. "Compared to that mummy he's been fucking," McCurry chuckled, "why not?" Poor Hillary.

Without bothering to mention that it was off the record, McCurry assumed his joke wouldn't be reported, and it wasn't until that book. Washington is a very cynical place. Everything is stated carefully and deliberately, with the *intention* that it will be repeated. When McCurry told the *Chicago Tribune* in an interview that Clinton's relationship with *me* could turn out to have been "complicated," it was no slip of the tongue. He was fully aware that his observation would appear in print.

Unlike Richard Nixon, who never dreamed that *his* words would be published in a book, *Abuse of Power: The New Nixon Oval Office Tapes,* edited by Stanley Kutner: "Bob [Haldeman], please get me the names of the Jews, you know, the big Jewish contributors to the Democrats. Could we please investigate some of the cocksuckers?"

My mom is a member of the Book of the Month Club, and in their brochure they printed it "c*cks*ck*rs." Anyhoo, that's how everybody thinks of *me* now. I'm the nation's official c*cks*ck*r laureate.

The image of me on my knees giving head to the president has become a cultural icon. The irony is that *it never happened.* When Wolf

Blitzer from CNN asked Clinton at a press conference what he would like to say to me, Clinton smiled and said, "That's good, that's good"—referring sarcastically to the *question*—but it was extremely ironic, because that's *exactly* what I *imagined* he *did* say to me: "That's good, that's good." And I replied, "I gave you a blow job, but I didn't swallow." He started laughing hysterically, just like that time he did with Boris Yeltsin. Bill liked my sense of humor. That's why we went from flirtation to friendship.

However, the reasons I visited the White House thirty-seven times was not for Bill—it was to be with Hillary—*she* was the one who desired me physically. The rumor about her being a lesbian was *true.* And so my relationship with Bill *was* complicated. He just acted as a middle man for Hillary, and now, by denying an affair with *me*, he's telling the truth *and* taking the fall for *her*. In that sense, he's an incredibly loyal husband. Despite what the public may think, Bill is absolutely devoted to Hillary.

Everybody is watching so closely for him to commit the next indiscretion, but it would have to be with somebody he can *totally* trust, somebody who could suck the leader of the Western World's dick and *not* confide in a friend, or to somebody who *pretended* to be a friend. So, for a while, Bill is left with only Buddy's tongue for sexual companionship.

At least, Buddy won't lick and tell. And if I know my president, while Buddy is pleasuring him, Clinton will fantasize that it's a *female* dog.

Sarah Palin's Reality Sitcom

Referring to the Ronald Reagan presidency, Neal Gabler has written about "the triumph of entertainment over political ideology of any sort." And Kurt Andersen labeled Bill Clinton the "Entertainer-in-Chief." The voters are the audience, conditioned to fear and superficiality in commercials for erectile dysfunction and political campaigns alike, both having scary side effects. And now the injection of Sarah Palin and her family into the McCain vs. Obama campaign makes one wonder whether the winner of this race will ultimately depend on which candidate presents the better sitcom. It already *is* a reality show. Do you know what the difference is between a sitcom and a reality show? The laugh track. Otherwise, how would the masses be able to tell whether something is funny or not? Hmmmmm . . . In any case, we're pleased to present the pilot episode of:

BRIDGES TO NOWHERE

[Instrumental rockabilly music accompanies a montage of Sarah Palin in various contexts, as the opening credits are superimposed on these images: In a helicopter, using a machine-gun to shoot a wolf running away in the snow. As a contestant in the Miss Alaska competition. A

wedding photo. Burning a pile of books. Jumping high to block a shot in a basketball game. Seated at her desk in the governor's office. At a barbecue with her children. Giving a speech to a large crowd. At the bank, exchanging a wolf's left foreleg for a $150 bounty. Tossing her hat way up in the air and then shooting it down with a rifle.]

[Sarah and Todd are slumped down on the living-room sofa.]

SARAH: I'm exhausted and exhilarated at the same time. I was at the Learning Annex all day, taking that course in "How to Be a Vice President."

TODD: And I was interviewing potential nannies all day. No one fits the bill yet. But I just keep calling the agency. Maybe I'll try Craigslist.

[The telephone rings. Todd picks it up.]

TODD: Hello . . . thanks, I will. *[Hangs up the phone and clicks on the TV.]* That was McCain. *[Looks at* TV Guide *for the channel number and clicks the TV on.]* Keith Olbermann is doing a Special Comment about you on MSNBC.

OLBERMANN: When John McCain first selected Sarah Palin as his running mate, it seemed to me that it was the best "What were you *thinking*?" moment since Hugh Grant got caught getting oral sex from a prostitute in his rental car. I was sure that with Governor Palin as the

ambush candidate, Senator McCain would be ridiculed into a severe case of buyer's remorse, his impulsive choice would backfire, and there would then be an epidemic of *schaedenfreude* among Democats. But I must admit, Ms. Palin, you have, dare I say, a certain Machiavellian charisma, and I was not quite prepared for that. You said that you deliberately tried to make yourself look frumpy, what with those Kawasaki eyeglasses and that chocolate-rust cotton-candy hair-do, sort of like the secretary in a porn movie who takes off her glasses and shakes her hair loose, then she goes ahead and seduces her uptight boss right there on his own black leather executive chair. Or so the comedians tell me, I wouldn't know. But you might as well *be* the star of a porn movie, because your main qualification to be vice president is that you *have* a vagina and you *are* a cunt. Allow me to parse that for you, Sarah. When I say that you were appointed because you have a vagina, there is no way in semantic purgatory that McCain would have chosen a *man* who had exactly the same political positions and experience as you--except that your American flag pin is bigger--so his having a penis would simply not make one iota of difference. And, you're a cunt if for no other reason than, in your acceptance speech, using Barack Obama as a prototype, you demeaned countless dedicated and courageous community organizers across the

nation by pretending that, as mayor, you exercised *actual* responsibilities which ostensibly *they* don't have. And I am not being sexist here, Sarah, because I am also calling John McCain a prick, if only because he is against funding higher education for our young men and women who are fighting and being maimed and dying in Iraq and Afghanistan--McCain's pathetic rationale being that if they had that funding to look forward to, then they just might prefer to come home and go to college rather than re-enlist. So, you-the-cunt and he-the-prick have a very complementary relationship. Support our troops, indeed! McCain's idea of supporting the troops is to send them more antidepressants--one out of every eight is already *on* them--so they can go kick down doors and kill people but still feel good about it. Oh, yes, and Sarah, we must not forget how Cindy McCain described the basis of your foreign policy experience. She said, "Alaska is the closest part of our country to Russia." With allies like that, you don't need opponents. Cindy reminds me of Jessica Simpson, when she asked if a can of "Chicken of the Sea" was fish or chicken. What's next, Cindy will sing her own rendition of Rosemary Clooney's classic song, "C'monna My *Houses*"? And speaking of *rendition*, Sarah, I wonder what you think of the CIA flying prisoners to other continents where they are tortured. Hey, what ever happened to *Country First*?--they should be

tortured in *this* country--yes, this country that is so incredibly endangered by the Unholy Trinity of corrupt government, welfare corporations and evangelical religion. Incidentally, Sarah, wouldn't you agree that Rush Limbaugh--infamous hater of the "feminazis"--was a sexist when he boasted, "We're the ones with a babe on the ticket!" Inquiring minds want to know. Likewise, wouldn't you agree that McCain was a sexist when he was asked a question about Hillary Clinton during the primaries--"How do we beat the bitch?"--and he replied, "Excellent question." And wasn't it sexist of him to vote against equal pay for women? Just remember, Sarah, the only thing that John McCain wants more than to live in the White House is to have a *menage a' trois* with you and Cindy. Good night and good luck.

[Todd clicks the TV off.]

SARAH: I'll tell you something, Todd. I feel like a human dartboard for the media, but I'm developing a thick skin.

TODD: I know what you mean. I say, "Oh, yeah, media? *[Clutching his crotch]* Troopergate *this*!"

SARAH: And you know what, the campaign spinners who feed the media are just as bad. They're like the airport security people, who have to spend all day looking at a screen in order to focus on potential threats

in the shape of a gun or a knife or a hand grenade. Both campaigns--*they* have to focus on each other's opponents in desperate search of *anything* that can be deliberately misinterpreted to distract all the dumbed-down voters from the *real* issues like national security. At first, I thought that was the name of a bank. "Hurry up and invest your money at the National Security Bank--before they fail!" *[Sarah and Todd start laughing hysterically.]* And what about earmarks? Why, they're just political hickies....

* * *

[Piper is sitting on a rocking chair in her bedroom, with Trig on her lap, holding a bottle to his mouth with one hand, and continually licking her other hand in order to leave a saliva deposit, then smoothing down Trig's hair.]

PIPER: Come on now, Trig, I want you to drink your moose'n'banana shake. It tastes so delicious. And it's good for you too, even if the plastic bottle has poison lead in it because it's from China or somewhere. Listen, I'm sorry that you were like a circus prop at the convention. People screaming all over the place. But it's lucky they gave you a watchamacallit, a sedative so you could sleep through all that noise. And you didn't even know that you were being passed around like a

marijuana joint, huh? It's legal here in Alaska. Did you know that? But it has to be only one ounce or less. And then you have to smoke it in your own house. I'm gonna wait till I'm thirteen before I try it. Bristol and Levi smoke it when Mommy's out making a speech. If she was here, she'd smell it right away, so then they have to go somewhere else. Mommy says, "Pot may be part of God's plan, but not in *this* house." She's always saying that something is part of God's plan, but I don't understand what she means about that. Are hurricanes and train crashes part of God's plan too? Anyhow, you're not supposed to smoke anything when you're pregnant, right? Hey, Trig, you wanna hear what I think would be a nice name for Bristol's baby? Diversion. I didn't think of that by myself. I heard my teacher tell another teacher that Mommy's baby is a diversion. I think it could be for either a boy or a girl. Hey, my tongue is dry. I don't have any watchamacallit, any salvia left. Maybe if I just have a little sip of your moose'n' banana shake. *[Drinks from bottle]* It's really yummy...

* * *

[Track is riding a stationery bike in his room while talking with Willow.]

TRACK: I' m telling you, those Iraq Veterans Against the War were real traitors at the Democratic convention. I learned that they had the nerve to be in full uniform, and they were chanting, "My buddy' s in the foxhole with a bullet in his head--I called to get the medic but he' s already dead." But at *our* convention, just like the war in Iraq was a justifiable pre-emptive strike, so was the raid on the protesters before the convention began.

WILLOW: What happened? I was busy taking care of Trig.

TRACK: The police and the sheriff' s department seized material that could' ve been used to barricade roads, and spikes that could disable the delegates' buses. They confiscated slingshots and buckets of gray water and urine. It' s better to prevent using that stuff *before* it happens. They busted four people on suspicion of conspiracy to commit a riot, and detained dozens of others. They took boxes of pamphlets on free-speech laws in Minnesota, and booklets on how to protest legally.

WILLOW: That doesn' t seem right. I was listening to the radio, and a pundint was talking --

TRACK: You mean pundit--

WILLOW: --a pundit, he was talking about keeping protesters out of sight, they could only speak on P.A. systems in fenced-off, like cages, on

side streets, and I thought they were talking about the Olympics in China, but then I realized that they were actually talking about the protesters at *our* conventions.

TRACK: It's not the same. China is a Commie dictatorship--and here there were seventy-seven applications to speak--but not one single protester was given permission, and all those who applied were arrested before the games began. Way to go.

WILLOW: I heard that in St. Paul, even a *mime* got a permit to speak. And the people who *did* speak couldn't be heard. I mean, what about the First Amendment? We learned about that in school.

TRACK: Yeah, well, it doesn't apply to those anarchists on the opening day, with black cloth covering their faces, a few hundred of them, running around the streets, setting fires, throwing rocks, breaking windows, blocking traffic. It was the duty of the riot squad and the National Guard to stop those actions. Tear gas, pepper spray, rubber bullets, concussion grenades, whatever it took.

WILLOW: But what about the *peaceful* demonstrators?

TRACK: There were ten thousand demonstrators who were peaceful, and they *were* allowed to march against the war. All they had to do was follow the rules. When their permit expired at 5 p.m., they still tried to

march to the convention center, but the authorities had already blocked a couple of the bridges that led to the convention center. They blocked ' em with snowplows and gravel trucks, police barricades and plenty of manpower. I saw the protesters running toward one of those bridges, and they were being chased by police in riot gear and teargas masks, so then the protesters were stuck in the middle. Isn' t that great?

WILLOW: Ha-ha, the bridges to nowhere. *[Track and Willow giggle wildly.]* Y' know, I' m really gonna miss you when you go to Iraq.

TRACK: I' m gonna miss you too. Anyway, the thing is, our guys had to be prepared, starting months before the convention, because there' s all kinds of front organizations out there that the FBI had to get infiltrated, like the environmentalists and vegetarians who pretend to be just innocent special-interest groups. Same with farmers, attorneys, medics, reporters--a journalist, Amy Goodman and her producers, plus a guy from Associated Press on the sidewalk in front of a building where there was a huge party given by lobbyists for legislators with a band, Hookers and Blow, not to be confused with a terrorist band, Rage Against the Machine, and also a bunch of bloggers and a whole video collective called I-Witness--some people had to be roughed-up and handcuffed and arrested for trying to interfere with law enforcement. Their computers and

laptops and cameras and journals and diaries were seized. In some locations, even children had assault rifles pointed at their faces. In the military, this is all known as "anticipatory self-defense."

WILLOW: That's wicked. So tell me, are you nervous about going to Iraq?

TRACK: *[Stops pedaling and pulls up the left leg of his sweatpants, revealing a tattoo of Christ on his calf.]* Not as long as He's with me, and He will be, every moment, day and night.

WILLOW: *[Bends down and kisses the tattoo]* I really love Jesus. Whenever I close my eyes and pray, I don't know what God looks like, but I always think of Jesus, because I know what *He* looks like....

* * *

[Bristol and Levi are sitting on the living-room sofa, holding hands. He is wearing a T-shirt that says "Billabong."]

BRISTOL: Here it is Friday night, and we can't even go out anywhere, because everybody points at us and stares at us and talks about us. It makes me feel like a real freak.

LEVI: How do you think *I* feel? All I ever wanted to do is play hockey and hang out with the guys and party like mad and get stoned out of my gourd and just chill out. I don't give a shit about *politics*. If we didn't

get drunk and screw in the tent outside that party, I never woulda had to go to that fuckin' Republican convention with your parents, who hate my ass off but they pretend we're one big happy family.

BRISTOL: Oh, c'mon, if my mother gets elected--like I wasn't planning to live in Washington, D.C.-- but it'll be fun. Please, don't be such a grouch.

LEVI: You saw my MySpace page. I mean *everybody's* seen it. "I'm a fuckin' redneck who likes to snowboard and ride dirt bikes." I'm too young to get married. I'm trapped. I was just minding my own business, and suddenly my whole fuckin' *life* is destroyed.

BRISTOL: Look, I don't wanna argue with you any more. Let's just see what's on TV.

[Levi reaches for the remote control and clicks on the TV.]

DAVID LETTERMAN: Here's good news, ladies and gentlemen. The Palin family crisis has been solved now, and today the baby is being adopted by Angelina Jolie.

LEVI: Boy, I sure wish *that* was true. I never wanted to have kids.

BRISTOL: Please, this is not exactly a picnic for me. Let's just see what else is on.

[Click!]

JAY LENO: Governor Palin announced that her seventeen-year-old unmarried daughter is five months pregnant. And you thought John Edwards was in trouble *before*. Now he's *really* done it.

[Click!]

CONAN O'BRIEN: Sarah Palin said, "We should never have introduced her to John Edwards."

[Click!]

CRAIG FERGUSON: I don't think that a young lady getting pregnant should even be news. Unless John Edwards is the father. Then that *is* kinda news.

[Click!]

BILL MAHER: Palin has five children including an infant that has Downs syndrome. She had it when she was forty-three years old. And it looks a lot like John Edwards.

[Levi reaches for the remote control and clicks off the TV.]

LEVI: That's really great, Bristol. John Edwards fucked you *and* your mother . . .

* * *

[Sarah is sitting at her computer when there is a knock on her office door.]

SARAH: Come in. *[Willow opens the door, walks in and sits down.]* I' m just looking over my stump speech here. It keeps changing.

WILLOW: Mom, I have to talk to you.

SARAH: Yes, dear, what' s on your mind?

WILLOW: *[Pausing]* I' m . . . pregnant.

SARAH: Very funny.

WILLOW: Mom, I' m not kidding.

SARAH: Willow, you' re only fourteen years old! How could you be pregnant? Are you sure?

WILLOW: I did the test three different times. They all said "Positive." I can feel changes in my body.

SARAH: This is horrible. I mean wonderful, of course. God always has a plan. Who' s the father?

WILLOW: *[Pausing]* It' s . . . Track.

SARAH: What! How can that be? He' s your brother! You had sex with your brother?!

WILLOW: I still don' t understand *how* I got pregnant. He borrowed a condom from Dad' s sock drawer.

SARAH: I' m shocked beyond belief. When did this happen?

WILLOW: Let' s see, the first time was--

SARAH: The *first* time! Did he force himself on you?

WILLOW: Well, not really. It was voluntary.

SARAH: Oh my God! What are we gonna do? Oh my God! I'm hysterical! Oh my God!

* * *

[Todd is finishing up an interview with a beautiful young woman in his office. He tries unsuccessfully to avert his eyes from her cleavage.]

TODD: Well, your resume' is solid--I'm totally impressed with your experience as a nanny--you have excellent references, you have a very enthusiastic personality, and I must admit, of all the women I've been interviewing, you're not only the most qualified, you're also the most attractive, if you don't mind my saying so.

NANNY: Oh, I don't mind at all, Mr. Palin. As a matter of fact, the feeling is mutual.

TODD: Please, call me Todd.

NANNY: Todd. Such a nice masculine name. *[Standing]* When would you like me to start?

TODD: I'll have to figure that out with Sarah when she returns. *[Standing]* She's meeting with Senator McCain today.

NANNY: *[Slowly moving toward him]* Then just be sure to call me whenever you know.

TODD: *[Slowly moving toward her]* All right, I will.

NANNY: You have my number.

TODD: And you have my number.

NANNY: I certainly do.

TODD: *[They are standing just a few inches from each other.]* The kids are really gonna *love* you. *[Gradually they embrace, He moves to kiss her on the cheek. She turns her head so that their lips touch, leading to a passionate kiss.]*

NANNY: *[Mumbling between kisses]* I feel like Jude Law's babysitter.

TODD: *[Mumbling between kisses]* Who's Jude Law?

NANNY: *[Unbuttoning his shirt]* He's a British actor who made love with his girlfriend Sienna Miller's babysitter on the billiards table.

TODD: *[Unbuttoning her blouse]* I don't have a billiards table, but I do have a cue-stick.

NANNY: *[Unbuckling his belt]* Oh, I know you do, I can feel it . . .

* * *

[Sarah is pacing back and forth at her meeting with John McCain.]

McCAIN: Calm down, Sarah, have a seat, take it easy.

SARAH: *[Sitting down]* I' m still in a state of shock. My heart is beating so fast. I have terminal dry mouth. This is awful.

McCAIN: Let' s review the situation. Your seventeen-year-old daughter is pregnant. And your nineteen-year-old son is the father. It was consensual sex. Nevertheless, that' s *statutory* rape. I think we have only two options. One, she gets an abortion.

SARAH: I' m sorry, that' s off the table. I mean it' s out of the question.

McCAIN: Look, I realize that you' re against abortion based on your religious principles, even in the case of rape or incest. And in this case it' s both. But you' re not against abortion if the life of the mother is endangered. That could be our exit strategy. There' s a blind doctor in Washington who performs the safest possible abortion, and he wouldn' t even know who the patient is.

SARAH: Absolutely not. Here' s what I thought about on the plane. Of course, we will never identify Track as the father--I' m so angry I found myself hoping that he would get killed in Iraq, and that would be perceived as such a heartbreaking patriotic sacrifice--I wanted to offer a bounty for the delivery of Track's severed left calf with the Jesus tattoo,

and yet I don't want him to be indicted and sent to prison for who knows how many years. What we *can* do is to place the full blame on a stranger who was wearing a stocking over his face so that there will be no description except for that detail. Willow didn't report it because she didn't have enough cash to pay for a rape kit, and she felt afraid to tell me until she was sure that she was pregnant. But she *will* be giving birth to that baby. And when Track returns home from Iraq, he will help raise that child, pretending he's only the uncle, which he actually *will* be. We could even announce Willow's pregnancy as an October surprise. That would endear our Christian conservative base to us even more than now, and it could provide a surge--excuse the expression--to our popularity.

McCAIN: Just because it worked in Bristol's case, that doesn't mean it will also work in Willow's case. I hadn't quite considered an announcement like this as a possible October surprise. I thought we might capture Osama bin Laden. Or that there could be impeachment and conviction of Bush and Cheney, but it would leave Nancy Pelosi as the new president, and we surely don't want *that*. Maybe Obama would be assassinated, then there would be rioting all over the country, there would be martial law, the election would be canceled, and the Bush administration would remain in power. Or the October surprise could be

dropping bombs on Pakistan. Or an air strike on Iran. Even if Israel did that, it would be with U.S. aid and approval. Also, there's a scenario floating around that Joe Biden will drop out of the race in deference to Hillary as Obama's vice-presidential running mate replacing Biden. That would really ruin our chances of winning.

PALIN: So tell me what the second option is.

McCAIN: That *you* drop out of the race. It's the honorable thing to do.

PALIN: What are you gonna do, kick me off the island? Let's face it, John, if I dropped out, you'd lose the election for sure, and you know it. You need to show me off during this campaign. I'm your biggest asset. I wanted to go on my own Palin Talk Express tour, but no, your neocon friends--*they* discovered me a year before you and I met--and now they're so afraid I can't function without their guidance. They're like a mad beehive, spouting campaign buzz words at me. But I will *never* drop out of this race. I would sooner give to the media my tape of our one-night stand in my hotel room at the governors' conference last February.

McCAIN: If you were to do that, I would release *my* tape of *this* whole conversation. So we're just canceling each other out with such tactics. But that's what I like about you. You're such a feisty lady.

Y' know, Sarah, if we get elected, I was hoping that our little tryst in Washington could happen again, perhaps this time in the Oval Office.

PALIN: Thanks but no thanks.

McCAIN: I remember you were *so* pregnant then.

PALIN: And I remember exactly what you said. "Let me baptize your fetus with some maverick juice." How romantic. But you were lucky I was *already* pregnant, because it would not have happened otherwise, since, as you know, I' m against birth control. Raising children is performing a task that is from God. And I believe that life begins *before* conception.

McCAIN: You and the Bush administration. They also consider birth control to be a form of abortion. The Health and Human Services Department is secretly trying to redefine contraception--the Pill, IUDs, you name it—redefine as abortion. So this federal agency could eliminate many state laws. Pharmacists could refuse to supply women with birth control devices. Insurance companies wouldn' t cover contraception. Rape victims wouldn' t have access to the morning-after pill. You have your beliefs and I respect them, but I' m trying to distance myself from George Bush.

PALIN: Except for his speechwriters.

McCAIN: Oh, you're referring to Matthew Scully and your acceptance speech at the convention. He's great. By the way, he asked me to pass on a line to you for the stump speech when you're talking about Obama: "Charlie Manson was a community organizer!"

PALIN: That will definitely get a good response. We need as many applause lines as we can muster up. Maybe *every* sentence should get a reaction. Clapping, laughter, cheers. The audiences always get off on that. They feel high and they associate it with us.

McCAIN: Fine, at least we're back on the same page again. Now promise that if you do become vice president you won't arrange for me to be killed by the grace of your powerful buddies in Alaska so that you can then become president.

PALIN: Okay, I promise not to have you killed--unless you decide to run for a second term. *[They both chortle nervously.]*

* * *

[The TV set is on, but nobody is watching. A commercial is playing.]

VOICEOVER BY ALEC BALDWIN: *[Images of Sarah Palin waving to huge, screaming crowds, signing autographs and being surrounded by paparazzi.]* She's the biggest celebrity in the world. *[Video footage of Michael Jackson and Michael Richards are superimposed as if they are in*

the company of Sarah.] But is she ready to lead? John McCain knows full well she isn't. With the energy shortage looming, McCain says no to windmills and solar power. And with the economic crisis already upon us, McCain says he'll cut taxes by lowering payments for Social Security and Medicare. More suffering, increased drilling. That's the real McCain.

[The face of Joe Biden fills the screen.}

VOICEOVER BY JOE BIDEN: I'm Joe Biden and I approve this message. Let me just add that when one of John McCain's top economic advisers, former Senator Phil Gramm, was quoted that the United States was only in a "mental recession" and had become "a nation of whiners," he unintentionally revealed the massive disconnect between the citizens of this country and their representatives . . .

[A few minutes later, Biden is still talking, when Nanny walks into the room, cellphone to her ear, and shuts off the TV.]

NANNY: Yes, hello. Is this the *National Enquirer*? . . . Oh, good. I'd like to speak to a reporter, please . . . Thank you, I'll hold . . .

[A split screen shows Nanny and the Reporter on split screens.]

REPORTER: Hello, what can I do for you?

NANNY: Yes, hello, I have a story that you might be interested in. I've been having an affair with, you know, the First Dude, and now it seems that I'm pregnant. What would the *Enquirer* pay for my story?

REPORTER: Do you have any proof that he's the father?

NANNY: Actually, yes, I *do* have evidence--DNA, physical evidence, like in *CSI*--I saved what was left of his semen in the condoms.

REPORTER: But then how could you be pregnant?

NANNY: He told me that his wife makes tiny pinholes in the reservoir tips of his condoms [in Sarah's voice] "in order to give all those *teeny little spermies* a fighting chance."

REPORTER: Why doesn't he just get a vasectomy?

NANNY: Sarah says that would be like cheating God . . .

[As the closing credits roll by, Britney Spears sings the program's theme song, "Oops, I Did It Again."]

SUBCULTURES

And Whose Little Monkey Are You?

Sometimes I think I'm dreaming when I read the news. But there are places where the inhabitants have never seen a magazine or a newspaper, and it is simply not a part of their psyche to dream about lines of type. In a spurt of generosity, the United States shipped surplus battery-operated TV sets across the sea to one group of islands in the Pacific Ocean, so that those natives could pass directly from a preliterate society to a post-literate society without having to read a single book in the process.

They watched in amazement as so-called psychic Uri Geller bent forks on the Merv Griffin show. The strange thing was that even though Geller accomplished this feat by trickery, there were young children back in America who hadn't yet been taught about the self-fulfilling rules of 20th Century physics, and to their parents' dismay, *they* were able to bend various kitchen utensils by means of sheer will power.

* * *

As more and more deadly conflicts around the world continue to escalate, more and more people are saying, "Boy, the shit's really gonna

hit the fan now." That phrase, incidentally, did not come into the language until after there was electricity. People say that they are not referring to a lovely Japanese lithograph showing a kimono-clad woman whose long shiny black hair is twisted up into a bun, and who is coquettishly providing her own personal breeze with a colorful rice-paper fan. Then *splat!*—right in her porcelain-like face. So, no, it has to be an *electric* fan, which revolves so fast it protects you from the shit—or spreads it, depending which side you're on—or what's a fan *for*?

Meanwhile, even as all that shit is hitting all those fans, the laxative industry continues to blossom. New brand names are constantly competing in the open marketplace. Ex-Lax has even come out with a "milder" version for women—certainly an indication of rampant male chauvinism in their Research & Development section. What's the implication of this trend? Do females have different digestive systems than males? Is it perfectly acceptable for macho men to have chocolate-covered sandpaper coursing through their intestinal tracts?

And yet credit must also be given to those friendly folks at Ex-Lax. They were the very first sponsor on television to include a sign-language translation of a commercial—a long-overdue service for the constipated hearing-impaired. Indeed, this had been an early demand of the Deaf

Liberation Front. You've probably seen their frontline members on the street and in airports, selling little cards with the sign-language alphabet. Some have been getting arrested for being deaf without a license. Naturally, the police recite their Miranda rights, shouting, "*You have the right to remain silent!*"

Anyway, this particular Ex-Lax commercial features a pleasant, matronly woman reminiscing through her family photo album while a young fellow in the corner of the screen ostensibly translates the message into sign language. Actually, he can say whatever he wants. Nobody monitors his translation. He can indulge in private jokes for all the deaf viewers and only they will know.

The matronly woman in the Ex-Lax commercial says: "Thank God my family is *normal*." The young fellow shifts the emphasis slightly in his translation: "Thank God *her* family is normal." She continues: "Of course, once in a while somebody in our family will be troubled by irregularity." He translates: "No shit." She concludes: "So then we do what we've done in our family for generations—we turn to an old friend, Ex-Lax." He translates: "Jimmy Hoffa knows too much."

And while the hearing-impaired at home giggle at this mistranslation, all over the globe the shit continues to hit the fans.

* * *

These are rough times, but it's extremely important to develop a sense of optimism. The *Bulletin of Atomic Scientists* periodically updates a clock on their cover to indicate how close we're moving toward nuclear war. Recently they moved it from four minutes to midnight to three minutes to midnight, with midnight representing total annihilation. I don't know exactly what their time scale is—whether one minute represents a month or a year or a decade—but, whichever, they're saying that we are all now only three minutes away from the ultimate holocaust.

That's the bad news.

The good news is that atomic scientists are just as fucked-up as the rest of us. They overeat, they forget to floss, they don't have time for serial orgasms, or they suffer from premature ejaculations, and they set their clocks fifteen minutes ahead so that if they need to mail a letter by six o'clock and their clock says it's ten after six, it means they still have five minutes to get to the mailbox. So that clock on the cover of the *Bulletin of Atomic Scientists* is fifteen minutes fast. We don't have just three minutes till doomsday; we have *eighteen* minutes.

* * *

Life remains peaceful on a certain island off the coast of Japan. Here, humans and animals live in peace and harmony.

There are monkeys who for eons have subsisted entirely on sweet potatoes. They would pick the sweet potatoes right out of the dirt in which they grow—eating them, dirt and all. This is the way they have always done it. But one day, for whatever mysterious reason, an individual young female monkey carried her sweet potato to the shore, washed the dirt off in the ocean and proceeded to eat the sweet potato.

Who knows why it was this particular monkey? Any explanation will suffice. Maybe she was an Aries, with a strong pioneer spirit. At any rate, once this monkey broke the ice, other monkeys began to wash the dirt off their sweet potatoes before they ate them. But only the young monkeys.

It was not until the 100th young monkey had washed the dirt off a sweet potato in the ocean--not exactly the 100th; it could' ve been the 93rd or the 108th; the 100th monkey is merely a metaphor for reaching critical mass—but not until then did the first *adult* monkey wash the dirt off a sweet potato. This was a case of reverse generational influence.

And then *other* adult monkeys started to imitate this behavior. Washing the dirt off sweet potatoes even began to occur on adjoining

islands, indicating that there was some kind of psychic communication in the air.

Now, how can this living New Age parable be applied to *human* behavior? Well, whatever you do personally to help further the cause of justice and the pursuit of ecstasy, even though you might get discouraged, you must always remember that you might be the one who turns the tide—you have to act as though *you* are the 100th monkey—and this gives us reason to hope.

That's the good news.

The bad news is, those monkeys *needed* that dirt in their diet for roughage. So now there were all these monkeys on this island who weren't able to shit.

But it just so happened that this was one of the islands where we shipped our surplus TV sets. Across the island, monkeys were gathered around those TV sets, all watching a program that was sponsored by Ex-Lax. Moreover, here was that commercial with the sign-language translation. And, fortuitously enough, these monkeys had relatives trained at Stanford University, where they learned how to communicate in sign language, and had been returned to the island to teach others of their species how to sign.

That's the good news.

The bad news is that this was the Ex-Lax commercial where the brand name of the product was not translated. The message in sign language was "Jimmy Hoffa knows too much." These monkeys—serving as shock troops of the Deaf Liberation Front—took that private joke to be their marching orders. So, even though you may have heard the propaganda that Hoffa was killed because he was prepared to speak out about the alliance between military intelligence and organized crime, the truth is that he was eaten to death by hordes of constipated monkeys.

The good news is, they washed the dirt off him first.

* * *

It is several years later now. Things have returned to normalcy.

The monkeys on those islands off the coast of Japan still watch TV, but they no longer wash the dirt off their sweet potatoes, and they are just as regular in their defecation as they used to be.

But in America, those children who once bent kitchen utensils to the dismay of their parents have grown up. One such young man now works on the assembly line in a missile factory, and he is able to bend certain working parts out of shape through the use of sheer will power. Soon

others will follow suit. Already the intelligence agencies are training their operatives in methods to counteract this kind of psychic sabotage.

The Mime and the Pacer

I found myself walking around and around in a counter-clockwise circle on the stage of the Wallenboyd Theater in downtown Los Angeles, just as a young man known as the Pacer does for several hours every day, always in the same direction, at the exact same spot in the mididle of the boardwalk in Venice Beach. He is an inspiration to me and I sometimes talk about him in my performances.

The boardwalk in Venice is both literally and figuratively on the edge of this country. T-shirts are the hieroglyphics of our time. Here, a grungy wino, who needed a shave long before Don Johnson made stubble fashionable, is wearing a T-shirt that says "Yes, I Am a Model." There, a nerdy tourist is trying not to let the pizza drip on his T-shirt that says "I Choked Linda Lovelace" (the porn star of *Deep Throat).*

The boardwalk resembles one of those double-page-spread montages in a children' s book showing many different modes of transportation being used simultaneously. Airplanes fly by, trailing printed messages such as "The New Dating Game Wants You," and

"Scientology, Give Us Our Money Back," while below, roller-skaters and skate-boarders mingle with cops riding bicycles and Hare Krishnas preparing for their annual parade featuring an elephant nourished entirely on trail mix.

A lone Jesus freak walks along and yells at them— "Antichrist! Antichrist! Antichrist!" —trying to drown out their chant. "Repent, Krishna! People are starving in India every day because these foolish Krishnas refuse to eat the cow! Eat the cow and believe in Jesus Christ! Repent, Krishna!"

You can buy all types of stuff along the boardwalk—rainbow sunglasses and fake Rolex watches and falafel-shaped yo-yo's. "But," complains a flower vendor who pays $600 a month for a ten-by-two-foot space, "rent will be going up to $800 and then to $1200 by summer. Venice will eventually be inhabited by a bunch of wealthy lot owners and a population of slaves who work for them."

However, the performers pay no rent, dependent on voluntary donations. There is a poet who speaks professional gibberish; an artist who draws on the ground with colored chalk; a fellow who juggles an electric chainsaw, a bowling ball, and an apple, for which strangers put money in

his hat because they're grateful to God that *they* don't have to do such a bizarre thing to earn a living.

There is a woman who plays the violin while standing on her head. And a man who has a table covered with wine glasses of different sizes filled to varying heights with water, and he plays this musical instrument by rubbing his fingers around the tops of those wine glasses. Audiences gather spontaneously to here his rendition of a Mozart sonata or a ragtime melody or the theme from *Chariots of Fire*.

There are breakdancers who bring their own personal linoleum-floor sections, and a jogger who jumps hurdles over the endless row of garbage cans lined along the boardwalk. He has to avoid one garbage can because a homeless person is foraging for lunch.

If I had to choose my favorite moment on the boardwalk, it would have to be the time a Rastafarian yogi was standing on the very top of a wooden chair, preparing to jump barefoot onto a pile of freshly broken bottles. "This is serious shit," he reminded the large semicircle of onlookers. And then, during the anticipatory silence, along came that Jesus freak. Upon seeing this crowd, he edged his way in. Now the Rastafarian yogi was poised upon that unseen edge between "Look before you leap" and "He who hesitates is lost." Suddenly the Jesus freak called

out, "Hey, wait, before you commit suicide there, how do you feel about abortion?"

* * *

In front of the Sidewalk Café on the boardwalk, the Mime, a black man wearing white gloves along with a tuxedo and top hat, just stands still—often for hours. He is listening to a stereo headset. One might think he was playing music to counteract the boredom, but it's really a tape loop reminding him, "Don't move, stay still, it doesn't matter if your back itches, people are paying you not to scratch . . . "

Passersby do indeed put cash in the cardboard box at his feet after they have gaped at him long enough to get their money's worth. Standing still is his job. People pay him not to move. When he goes to the Unemployment office, a clerk asks, "Did you look for work this week?" He answers simply, "Yes, I stood on the corner of Hollywood and Vine, and then I stood on the corner of Beverly Boulevard and Sierra Bonita, and then I stood . . . "

In contrast to the Mime is the Pacer, who intrigues me most. He doesn't call himself the Pacer. He may not even know that others do. But the circle he walks around and around in is his turf. Even an occasional

police car respects the force field he creates, and the cops drive around him.

Obviously he originally started this strange stint as a matter of choice. "I think I' ll walk around in circles on the boardwalk today." And the next day. And the next. But somewhere along the way, walking around in circles became a compulsion, and *it* started doing *him*. When you play a role long enough, the role can begin to play you if you' re not careful.

I' ve been out at six o' clock in the morning and there was the Pacer walking in circles. I' ve been out at six o' clock in the evening and there was the Pacer walking in circles. He does stop to eat—which indicates that at some level he is still acting voluntarily. He walks in a straight line to a greasy-spoon diner nearby on the boardwalk and sits at the counter, but he doe not twirl on his stool, nor stir his coffee, nor roll his eyes.

Once he talked about his obsessive activity: "I' m in control of walking, but out of control too. When I walk I' m in a trance. If I slow down at night I see colors. I see millions of faces—some with Pilgrim hats, some with cowboy hats—modern faces and prehistoric faces."

There must be some kind of spiritual path that the sweating, red-faced Pacer keeps treading, even if it' s circular--some unique relationship

with the universe by which he justifies his existence to himself. Everybody has to feel they' re making *some* contribution to society, if only to maintain self-esteem. Even those who work in a missile factory must rationalize, "Well, the United States needs to have a strong defense."

It' s an absurd age we live in. *Future Shock* is already an outdated book. Children whose shoes stay on their feet by the grace of Velcro may never experience the thrill of tying their shoelaces in the dark. They have developed a fast-food approach to perceiving time because all they know is digital clocks. Time goes *click, click,* and if the power goes off they think that 12:00-12:00-12:00 is appliance language for "Help! Help! Help! Turn me back to the right time! Help! Help! Help!"

Kids have lost that certain sense of time in motion, going around and around, eternally. That concept is endangered, just like the whooping crane. But we can all be grateful to the Pacer, for he is the Keeper of the Counter-Clockwise. *That* is his spiritual calling. But the Pacer doesn' t have a cardboard box for people to drop money into—he walks around in circles out of the goodness of his heart.

* * *

The Mime and the Pacer provide a perfect metaphor for the two-party system in America. The Republicans are like the Mime, standing

absolutely still while the world passes them by—Iran, Iraq, Nicaragua, El Salvador—and they get paid for it, just like the Mime. The Democrats are like the Pacer, walking around in circles while the world passes them by—Israel, Libya, Cuba, Honduras—and they *don't* get paid for it, just like the Pacer.

But recently the Pacer did something that hurled such a comparison right into the metaphor graveyard, along with "That's like bringing coals to Newcastle" (for Newcastle finally *did* run out of coal) and "Good as gold" (since the government now prints money without the benefit of the gold standard). The Pacer had put a cardboard box down on the ground and started walking around it. And now people began giving him money.

By the mere presence of that cardboard box, the Pacer had transformed his personal perversion into a marketable talent. Just like so many of us. And I could no longer feel superior to him. He was not just some nut walking in circles. Now he was earning a living.

I still "do" the Pacer in my act, but with increased respect. "His job is no less dignified than anything *we* do," I tell the audience. "He works hard all day, and then, just like you and me, he goes home and unwinds." And I proceed to walk around and around in a circle onstage, only now in a clockwise direction.

Johnnie Cochran Meets Dr. Hip

Tragedy and absurdity were two sides of the same coin: On one side, O.J. Simpson's "suicide" note with a smiley face in the O of his signature; on the other side, the woman who pinched Simpson lawyer Robert Shapiro's ass because "I wanted to be part of history." And somewhere along the ridge of that coin was Simpson himself, walking into the courtroom humming the melody of "Touch Me" from the Broadway hit *Cats* and explaining to reporters that he was thinking about his children.

That was at Simpson's criminal trial. Shortly before his civil trial began in 1997, I met his lead attorney, Johnnie Cochran. He was the guest of honor and luncheon speaker at a national convention of criminal defense attorneys held in a huge banquet hall at a hotel in Santa Monica. No media people were allowed entry.

One of the attendees was Dr. Eugene Schoenfeld, also known as Dr. Hip from his days as a syndicated columnist for the underground press. He now testifies occasionally as an expert witness, and was at this event for that reason. My wife Nancy and I were his guests.

Cochran's speech reassured the enthusiastic audience: "In the Simpson matter, we just did what *you* do every *day*" —that is, defend their clients by any means necessary and chalk up a bunch of billable hours in the process—and he got a standing ovation.

In the afterglow of his speech, colleagues came up to Cochran to shake his hand and get in a little banter. One well-wisher shared this joke: "If [prosecutor] Chris Darden spent as much time trying to nail O.J. Simpson as he did trying to nail [prosecutor] Marcia Clark, he might've won the case." The other defense attorneys within hearing distance all had a good laugh at that one.

Dr. Schoenfeld joined the line of lawyers waiting to have photos taken of themselves standing alongside Cochran. When it was Schoenfeld's turn, Nancy focused her camera. For this particular occasion, Schoenfeld had stashed a hand-printed card underneath the standard, plastic-encased ID lapel card. As in the previous poses, Cochran and Schoenfeld put their arms around each other, although they were looking, not at each other, but straight ahead and smiling at the camera.

Thus, Cochran didn't notice how, just before Nancy snapped their picture, Schoenfeld subtly managed to pull away the ID card and reveal the hand-printed card, which declared, in large printed letters, "O.J. DID

IT!" I published that photo on the front cover of *The Realist* that spring. It was the result of a good old-fashioned guerrilla action.

Jealousy At the Swingers Convention

The 24th annual Lifestyles Couples Convention has filled three hotels in Palm Springs, California. The Convention Center is connected to one of them, the Wyndham, which surrounds a large outdoor pool and patio populated by couples busy socializing in 116-degree dry heat. Women and men alike are wearing thongs. From afar they appear like so many eyeless smiley faces among the bathing suits. The law that Sonny Bono signed when he was mayor, banning thongs in public, does not apply to this event, or, for that matter, to Cher.

The convention is for couples only. Except for me. I've been hired to perform stand-up comedy at their Friday luncheon, and I'm here alone. On the small, propellor plane from Los Angeles to Palm Springs, the right side consists of two-seat rows, occupied entirely by couples on their way to the convention—horny with the expectation of getting laid by the spouse of a stranger, perhaps sitting in front of or behind them—and the left side of the plane consists of one-seat rows, occupied entirely by me. I'm afraid that the plane might tip over upon trying to land.

At the Convention Center, even the plastic-encased lapel nametags are coupled off: "Ken and Barbie" on his, "Barbie and Ken" on hers. Not all the couples are paired off in real lie, though. One person can simply bring along another—known in swinger circles as a "ticket" for gender balance—in order to get into the convention. So everybody has entered two by two, and I feel like a unicorn stowaway on Noah's Ark, surreptitiously balancing on the cusp of love and lust.

There are 3,000 participants at this convention, mostly upper-middle-class, in their 30s, 40s and 50s. They consider people in the outside world to be "straight," even though one would ordinarily consider *them* straight. I mean there are suburban soccer moms here, openly celebrating their secret lifestyle at an oasis of supportiveness. There's a man in a suit with a flesh-colored penis necktie, another wearing a T-shirt declaring "I'm Not Going Bald, I'm Getting More Head," and another dressed only in a leather jockstrap, who recognizes me and introduces himself.

"I'd give you my card," he says, "but I have no place to keep them."

Inside the 100,000 square-foot Convention Center, the Exhibit Hall has been turned into an "Adult Marketplace," buzzing with commercial activity. I overhear one shopper's complaint: "But we've *already* spent

$400." There's a multitude of merchandise on display—pornographic videos, naughty lingerie, fetish paraphernalia, edible lotions—plus booths galore. At the Golden Nipples booth, women are cheerfully having exact duplicates of their nipples created in sterling silver or 14-karat gold, which can be used as pendants, key fobs, money clips or—yes, of course—nipple covers. At the Penimax booth, an Asian vendor is selling disposable cock rings, which, he promises, will maintain my erection even after I ejaculate.

There are several booths dedicated to booking vacations especially designed for swingers, at nude beaches, clothing-optional resorts and ocean cruises. I follow around an elderly woman who is busy picking up brochures at every such booth. It seems incongruous, but I try not to indulge in stereotypes. Finally I engage her in a conversation, and she explains that her boss told her to get as much material as she could, because he owns some property surrounded by government land, and he wants to start a new business.

At the Erotic Massage Wear table, a woman uses my arm to demonstrate a device that turns her fingertip into a vibrator, not intended for nose picking. Then she puts Jergen's Lotion on my right hand, dons a pair of Love Mitts—made of vinyl with little nubs all over—and proceeds to massage my hand while on the VCR there's a tape of a woman

wearing Love Mitts and massaging a man's lubricated penis. This is a bizarre mixed-media sensation. Although I don't get a hard-on, the lobes of my brain seem to fuse, and for the next few hours my left hand persists in feeling neglected.

Checking out the functional furniture, I merely eavesdrop on a (fully clothed) couple testing out the "rocking torso feature" on a Love Table, but I actually *climb into* the Love Swing, assuming a position ordinarily assumed by a woman while the man stands up, crotch to crotch. My body is suspended half upside-down in mid-air with legs spread and feet up in stirrups. I'm feeling mighty vulnerable. As I hang there, the inventor hands me my tape recorder, then proceeds to show me how "the woman can place the man's penis on her G-spot by moving her legs from a position of being out front like this to being in the fetal position" and how "the man, instead of just going in and out like that, he can make his penis a joystick, so every step he takes is a movement inside of her, more like a dance step." He guarantees, "You'll never use a bed again."

Next I inspect the Bungee Sexperience—a harness designed by a company that makes bungee cords—it bounces in the air, so the "rider" can enjoy weightless sex in a variety of positions. I ask the woman demonstrating this how many hours a day she bounces up and down. "At

an event like this," she responds, without missing a bounce, "I'd say eight to twelve hours." She tells me that her circulation is excellent, and that her 18-year-old son refers to the contraption as a "bungee humper." In addition to bouncing, it can also create "the illusion of bondage, yet the person can actually be comfortable while restrained."

The Auto Erotic Chair, however, provides *real* bondage. It's equipped with leather restraints and panic snaps for arms and legs, and comes complete with a power box, pneumatically operated anal and vaginal plugs. "Our power source unit is designed to stimulate nerve fibers throughout the genital areas by delivering controllable electro-pulse energy through conductive electrodes on our sex toys. Our precision-engineered technology gives you safe and pleasurable electric play." So, for example, in the Electro-Flex Penile Ring/Anal Plug Configuration, "A single conductor butt plug is used in conjunction with a single conductive cock ring to complete the circuit. With a single conductive cock ring, one side of a double conductive butt plug can be used to stimulate either the prostate or the sphincter."

If you'd prefer something, well, less electric, there's always the Crystal Wand, a 10-inch-long, *S*-shaped co-ed tool, hand-carved from pure crystal-clear acrylic, that doubles simultaneously as a G-spot stimulator

and prostate massager. I′m reminded of a swing party I heard about, one that took place at the Whispers Club in Michigan. Couples removed from the refrigerator 12-inch summer sausages and cucumbers that the hostess had planned to use for food that evening. When she walked into the "party room," she couldn′t help but notice that although the food was being consumed, it was not exactly in the fashion she had originally envisioned. Instead, the sausages and cucumbers were being utilized as organic sex toys.

As I continue to wander around the Adult Marketplace, I realize that the name of the game is penetration. All paths lead to penetration. But I′m not referring to penetration of the sexual kind, although that′s an implicit goal—pick an orifice, any orifice, and there′s always a corresponding appendage or gadget that can fulfill its desire for penetration—no, I′m talking about penetration of the *market*. There′s lots of money to be made here. The persistent question is, how can I penetrate this market? Maybe I could come up with a combination FM radio and vibrating dildo.

* * *

I′m beginning to feel like I′m experiencing an alien encounter, only *I′m* the alien here. Nevertheless, I′m aware that swingers and

comedians do have something in common. We both like to have a good opening line. As a performer, I always try to slant my opening line toward a particular audience.

My opening line at the World Hemp Expo was, "Last night, for the first time in my life, I used a hemp condom." My opening line at a Skeptics Conference, attended by the Amazing Randi and the Amazing Kreskin, was: "The is the first conference I've been to where there were two people with the same first name of Amazing—but the Amazing Randi was born with that name, it's on his birth certificate, whereas the Amazing Kreskin changed his name for showbiz--his real name is the Obnoxious Kreskin." And my opening line at a luncheon during the Los Angeles County Bar Association conference was, "I'd like to begin with a moment of silence, so that you can think about your client's problem, and then you can make this a billable hour."

Now I find myself in a lavish hotel suite, trying to crystallize an opening line while contemplating the bald spot on the back of my head, infinitely cloned in the mirrors of the hotel-room bathroom, actually the only place I ever get to *see* that bald spot as others do. This will be a serious opening line, since I have been told that, in the introduction to my performance, I will be presented with the Lifestyles Freedom Award. I

decide that my opening line will then be, "I just want to say that freedom of expression existed long before the First Amendment." Though it's not my motivation, I realize that this opening line will undoubtedly please Robert McGinley, the bearded co-founder and president of the Lifestyles Organization.

"We hate government intervention in our lives," he has assured me. "We hate censorship. We're against laws that require helmets for cyclists. It's good that a law was just passed allowing women to breastfeed in public, but we shouldn't need permission from the government to do it." He admits to being "libertarian, but not Libertarian Party." He draws his philosophy from Jack London— "The proper function of man is to live, not to exist" —and, more specifically, his credo is "Adult sexuality is normal." Dr. McGinley (he holds a Ph.D. in counseling psychology) tells me a riddle: "What do you call an Italian swinger?" I give up. The answer: "A swop."

At the luncheon, it turns out that I will *not* be presented with the Freedom Award after all, and I have to come up immediately with a replacement opening line: "I'm delighted to be at the Lifestyles Convention—this is the first convention I've ever been to that was named after a condom."

Indeed, condom consciousness (if not condom use) is present at the convention. In one workshop, "The ABC's of Swinging," condom etiquette is described as bringing "the right safety equipment, just as you would for scuba diving or parachuting." Another presentation on "Safer Sex" covers new drug therapies for AIDS, information on other sexually transmitted diseases that are increasing among heterosexuals, and "things you should be doing to protect yourself."

Originally, herpes had caused a certain panic in swinger circles. Some swing clubs closed, though private parties increased. But, paradoxically enough, with the advent of AIDS, *new* clubs opened, as if the disease were anti-climactic. Currently, there's a surge of growth in this subculture—thanks to the Internet—with estimates ranging from 2,000 to three million participants. And, according to Dr. McGinley, "There's been very little increase in condom use. It's the woman's choice."

Nonetheless, at the Adult Marketplace, a woman in a black lace negligee roams around giving out free samples of condoms. There are also Crème Cookie Condoms for sale. They appear to be vanilla and chocolate Oreo-style cookies, individually wrapped in cellophane. I ask the vendor whether these are condoms that look like cookies, or cookies that look like

condoms. She tells me that they are edible cookies, but each one has a condom inside.

"They're only a dollar each," she says, adding, as I edge away from her booth, "it's a great joke."

* * *

The Art Gallery at the convention Center, featuring the Lifestyles Convention's 7th annual Sensual & Erotic Art Exhibition, almost didn't happen. The state's Department of Alcoholic Beverage Control had tried to prevent it from opening. When their authority was challenged, an ABC representative became an alchemist, transforming logic into absurdity. Legally, he said, you can't even have sex in a hotel room which has a mini-bar. Sure, pal, just try to enforce *that* one.

Two days before the convention, the ACLU obtained a restraining order against ABC's interference with the art exhibit. But ABC didn't just give up and assume the fetal position in a Love Swing. Rather, the agency threatened to revoke the Wyndham Hotel's liquor license if they allowed a special two-hour session, the convention's traditional Evening of Caressive Intimacy, to take place in the Wyndham Ballroom on Friday as scheduled. This popular, closed-door, clothing-optional massage clinic, limited to the first 200 couples who sign up, would include the "human

car wash," involving, as one veteran swinger portrays it, "a lot of naked bodies and some serious rubbing."

But the ABC regulations on Attire and Conduct—behavior "deemed contrary to public welfare and morals, and therefore no on-sale license shall be held at any premises where such conduct or acts are permitted" —includes this clause as a no-no: "To encourage or permit any person on the licensed premises to touch, caress or fondle the breasts, buttocks, anus or genitals of any other person." The Wyndham chickens out, the massage clinic is canceled, the money is refunded, Lifestyles will sue the hotel for breach of contract, and next year's convention will be held in Las Vegas in 1998.

A lawyer, standing on the border of cynicism, suggests, "Just buy a town in Mexico and buy off all the officials."

In the previous year, 1996, the convention was held at the Town & Country Hotel in San Diego (for the fourth time), but two ABC officers claimed that they witnessed oral copulation in the convention hall, and the hotel's liquor license was suspended for five days, hence Lifestyle's move to Palm Springs this year. Lately, ABC has been spreading its particular brand of paranoia in Los Angeles, where the agency has raided gay, black and Latino bars in Los Angeles and in Hermosa Beach, where it

has imposed restrictions on restaurants, requiring patio patrons to order food with their drinks, and forbidding customers to dance. Proprietors now play less upbeat music so that nobody will be tempted to dance. Those who can't resist are asked to stop.

Incidentally, I find out that, instead of giving the Freedom Award to me, convention officials have decided to present ABC with an Anti-Freedom Award, but that notion gets lost somewhere in award limbo, along with my original unspoken opening line.

On Friday night, the massage clinic that doesn't take place is followed by the Wild West Casino and Dance. One man comes attired in a sheriff's outfit with a rubber penis drooping almost to the floor. A security guard tells him that he'll have to check it. Fake knives, guns and bullets are acceptable, but not a fake sex organ. Another cowboy, with a *real* (unloaded) gun, is stopped by a security guard, but he resists, asserting in his best John Wayne manner, "This is an 1887 pistol, and I'm not about to check it."

Several folks leave the dance at midnight to attend an unofficial 3rd annual spanking party. It ends at 3 a.m. with a bout of fist fucking. Dear Abby was right. One thing *does* lead to another.

* * *

I've been sampling many workshops at the Convention Center, and I notice that whenever I sit down on a chair next to a chair with someone else's stuff on it, and the owner of that stuff is sitting on the other side of that chair, they always tap the top of their stuff in a subconscious gesture of territoriality. I also observe that a man with one leg (he walks with crutches) and his wife seem to arrive at every single workshop that I attend. Hmmmmm. I'm beginning to get suspicious. Obviously, I've seen too many spy movies.

A cartoon in the 1991 convention program showed two rooms where lectures were being given. The attendees in the room featuring "Do It Yourself Porn: Make Your Own XXX Movies" were overflowing into the corridor, while the room featuring "Socio-Political Ramifications of Current Trends in the Erosion of Civil Liberties" was empty, except for the baffled lecturer. It was a nice touch of self-deprecating humor, an exaggeration not too far from reality. At this '97 convention, porn actress Nina Hartley's "So You Want to Throw a Party: Recipes for a Successful Orgy" attracts ten times more audience than attorney Bob Burke's "Sexual Politics: A Behind the Scenes Look."

Unfortunately, one workshop, "The Undertone of Sexuality in the *Star Trek* Series," has been canceled— "due," someone added to the

notice, "to Federation Regulations and Star Fleet Emergency Order 1007-932." Deborah Warner, in describing her presentation, had written: "Paramount and its parent company, Viacom, have a vested interest in presenting the *Trek* franchise as a family-oriented show. To this end, they overtly depict the characters as asexual. Yet there exists erotic subtext. This has spawned a very large community of fans who create volumes of explicit erotica that is enjoying great popularity in print and an explosion of interest on the Internet."

Now, outside the room where her workshop would have been, there is disappointment-- "Oh, and she was gonna bring a Klingon" --and nostalgia-- "Remember the time Quark and Deanna were French-kissing?"

That theme continues at "American Tantra: How to Worship Each Other in Bed," This workshop—whose motto, "Orgasm long and prosper," paraphrases *Star Trek's* blessing, "Live long and prosper" —is conducted by Paul Ramana Das and Marilena Silbey. "Interspecies intercourse," he muses. "This can't be the only planet where love is made." A writer for *AVN* (Adult Video News) has reviewed their *Intimate Secrets of Sex & Spirit* and confessed, "I've rarely laughed so hard in my life. No shit, this vid earns a pre-nomination for 'most

outrageous sex scene.' Paul actually uses Marilena's pussy as an echo chamber!"

Now, in his regular voice, he is telling our workshop of the need to "approach the body, not for sexual release, but for every single inch of this body, the groundwork, the geography of pleasure. Can anybody name one spot on your body that is not capable of receiving pleasure?" Nobody can. Later, the entire audience, seated around the perimeter of this extra-large room, is instructed to come stand in the center area and face their partners. I start to slide out, but not inconspicuously enough. Ramana Das, who knows me from a previous incarnation, calls out, "There goes Paul Krassner. Are you afraid to participate?"

"I'm here as a journalist."

"Ah, he can't participate because he's a journalist. See how everybody has excuses."

Suddenly I'm saddled with a dose of New Age guilt, as though I have aborted my inner child. Meanwhile, there's a lovely blonde who doesn't have a partner, and now I'm tempted to participate, but some guy who's also without a partner links up with her. Unexpectedly, my guilt changes to jealousy. Just a slight pang of jealousy, mind you, but a terrible taboo in this particular world.

Jealousy is an outmoded emotion to be shunned like dandruff. There's even a workshop that advises "How to Handle Jealousy" and another titled "Swing Without Guilt or Jealousy." And so now I not only feel guilty about not participating, I also feel guilty about feeling jealous. I've committed a swinger crime. I can hear security guards shouting "Jealousy alert!" Loud sirens go off. "Jealousy alert!"

Now where will I go? I have been reading about tantra in *Real Magic* by Isaac Bonewits: "Energy control is a very important part of the exercises; it is essential, for example, that during *Kama-kali* the male be able to refrain from ejaculating under the most harrowing circumstances." I decide to drop in on a workshop, "How to Prevent Premature Ejaculation," but everybody has already been there, and they all left early. Sorry. I blurted that out before I could stop myself.

* * *

There are swing clubs all around the country, from "Shenanigans" in Indiana to "Liberated Christians" in Arizona ("for Christians seeking liberation from false sexual repression based on mistranslation of scripture who wish to explore responsible non-monogamy and polyfidelity"). Many clubs designate themselves as Equal Opportunity Lifestyle Organizations,

where membership is open to all races, and they belong to NASCA (North American Swing Club Association).

The Spring 1997 issue of *NASCA Inside Report* editorializes:

"There are political attacks on freedom that citizens should be aware of. It is far too easy to lose, through complacency and ignorance, the freedom that we Americans cherish. These attacks include the proposed censorship of the Internet now under review by the U.S. Supreme Court, the recently court-upheld attempts by states to keep 'harmful' literature from the eyes of children by controlling street news racks, the reintroduction in Pennsylvania of legislation to outlaw swing clubs and a similar measure in California. Regarding the latter two, do we smell a conspiracy here?" If there is one, it's bi-partisan.

In Pennsylvania, Richard Kasunic, a Democratic state senator, failed in his 1996 attempt to outlaw "sex clubs." This year, he has reintroduced legislation to outlaw "swinger clubs." He states, "My bill will outlaw these immoral establishments in every community in Pennsylvania and provide significant penalties for those who choose to continue this offensive practice." The penalty for operating a swing club, even in one's own home: up to two years in jail and $5,000 in fines. For a second

conviction: up to seven years and $15,000. For patronizing a swing club: $300 plus court costs.

In California, Tim Leslie, a Republican state senator, has introduced a bill which would provide that "every building or place which, as a primary activity, accommodates or encourages persons to engage in, or to observe other persons engaging in, sexual conduct including, but not limited to, anal intercourse, oral copulation or vaginal intercourse, is a nuisance and shall be enjoined, abated and prevented, and for which damages may be recovered, whether it is a public or private nuisance."

Swinger periodicals range from *New Friends* to *Fuck Thy Neighbor*. Patti Thomas, author of *Recreational Sex: An Insider's Guide to the Swinging Lifestyle*, is editor at *Connection*, which publishes thirteen titles, including *Cocoa 'n Crème*, catering to interracial swingers (not to be confused with *Black 'n Blue*, catering to sadomasochist swingers). *Connection* is suing the federal government over a bill that Ronald Reagan sent to Congress in 1987, the Child Protection and Obscenity Act, an outgrowth of the Meese Commission on Pornography.

The specific statute being challenged—known as the record keeping and labeling law, or the ID law—was supposed to be aimed at child pornography, but has been applied to adults-only swing publications. It

requires anyone placing an explicit photo ad to provide a photo ID, nicknames, maiden names, stage names, professional names and aliases. These records must be available for inspection by the attorney general's office.

Connection had attempted to comply with the law by cutting out every explicit photo ad from its magazines and sending them with a letter to those advertisers, explaining the new law and its requirements, asking that they submit the proper ID or send a "soft" photo that didn't require ID. Out of 500 advertisers, only 26 responded with IDs. Patti Thomas spoke about this in her keynote speech at the Conclave '97 Convention in Chicago:

"It definitely makes it difficult to produce the magazine our readers and subscribers have come to expect, when you don't have enough so-called 'legal' ads to fill all those pages. And considering that *swinging itself is not illegal*, why should we have to 'register our sexual choices' with the government just to place a personal ad in a magazine? . . . I've never really thought of myself as an activist, or as one who was 'politically involved,' but over the last few years I think I've finally come to realizing that it's going to be *necessary* to be involved, even if it does mean 'exposing' my lifestyle to those who would repress it. I am

fucking sick and tired of do-gooders trying to tell me how I should live my life!"

In 1995, *Connection* filed a suit challenging the constitutionality of the law and seeking a permanent injunction. In 1997, the motion was denied. Attorneys filed an appeal and a motion for a temporary injunction relieving *Connection* from complying with the act during that appeal. The motion was granted.

"The justice system in this country just makes no sense to me whatsoever," Patti Thomas tells me. "As far as I know, once we do present our case to the Court of Appeals, if our decision isn't favorable, we will make every attempt to go to the Supreme Court. Our attorneys are the best First Amendment attorneys anywhere. Our lawsuit has been very costly, as you can imagine, but our company believes very strongly in fighting for our constitutional rights. Our suit was filed not only for the benefit of our company but because we felt that this outrageous law was totally infringing on the civil rights and freedoms of people involved in alternative lifestyles. Obviously, the average person involved in swinging would have no way of combating this law on their own."

I ask her whether attempts at repression have resulted in politicizing the swinger community.

"I'm afraid we haven't been very successful," she replies. "We try to inform our readers about political issues threatening our lifestyle and attempt to get them involved. Unfortunately, many in the lifestyle either don't believe that the government will actually take away their rights or are too afraid to make a stand. Swingers who have been 'exposed' as active participants in the lifestyle have lost jobs, family, community standing and friends as a result.

"People I've personally known who have lost their jobs when their swinging activities were discovered just wouldn't fight back because of the fear of further exposure through the publicity that could have been generated. As a matter of fact, my ex-husband was fired from a management position back in 1980 when someone discovered his photo in one our magazines and brought it to the attention of his superiors. Luckily, he was able to find a position with one of *Connection's* affiliate companies. So we pretty much remain an 'underground minority.'"

That point is underscored by a 29-year-old woman at the convention. "None of us like publicity," she says. "None of us want to be out in the open. The business world is very conservative." She is wearing an American flag bikini, although she has never heard of Abbie Hoffman. She was born the same year that he got arrested for wearing an

American flag shirt. Nor did she have any way of knowing that when he wore another American flag shirt on *The Merv Griffin Show*, his half of the TV screen was blocked out all across America. She was, in short, unaware of the roots of her own, limited freedom.

* * *

It's Saturday night, and the Carnival Masquerade Ball is being held in the huge Convention Center Ballroom. On the wall behind the stage are gigantic masks. Above the tables are gold and purple balloons, fashioned after either somebody's school colors or a Chinese restaurant's little hot mustard and soy sauce plate. The taped music is loud, and the dancing is raunchy, enhanced by gaudy yellow, blue and red lights. Pheromones are flying, and the costumes are kinky.

"Costumes," the program states, "may be anything of fertile imagination (genital area musts be covered) for an exotic night of adult social fun." Hey, look who's here: Superman. The Phantom of the Opera. The devil. Mickey Mouse and Minnie Mouse (in a see-through top). An executioner. An Arabian potentate. A gold-plated pharaoh. A chicken lady covered with big yellow feathers. A guy in a dog collar being led around on a leash. And the one-legged man, who is wearing a roller skate as his costume.

At one point, an announcement is made that the next dance number will be filmed, so anybody who doesn't wish to be recognized should get off the dance floor. About 80% of the dancers leave. Similarly, taking part in the costume-judging means that permission to be photographed is automatically granted, which results in many contestants not making themselves available to be chosen as possible finalists.

The Best Male Costume goes to a 75-year-old man dressed as a biker stud. The Best Female Costume goes to his 75-year-old wife, dressed as a biker slut. The Best Couple's Costume goes to a woman with *papier mache'* breasts the size of beach balls and her mate with matching enormous testicles but covered by pillowcases and a sign that warns, "Censored by the hotel and ABC."

A marriage ceremony is performed onstage. The blissful pair have written their own vows; nothing is mentioned about forsaking all others. The newlyweds, their party and a few other couples are invited to a gathering in the suite of a three-time Emmy Award-winning TV producer and his wife. It turns out to be a tantra-filled wedding night. All the women massage the groom, and all the men massage the bride. One woman, a computer animator who wants to become a sexual surrogate, predicts

that, as the millennium comes to an end, tantric men will be popping up everywhere.

A retired chairman and CEO of a title and escrow company, who attended another tantra party, tells me, "The difference between the tantra party and the party next door is the fact that at the beginning of the wedding tantra party there was a lot of ceremony and shared tantra ritual, but once we had experienced that, it was every person for themselves. It was like the party next door." These were closed parties by invitation only. But you didn't need an invitation for open parties. All you had to do was find them.

The Wyndham Hotel is permeated by a sense of uninhibitedness. In the elevator, a beautiful black woman is looking in the full-length mirror and admiring her new Clit Clip—non-piercing, adjustable, genital jewelry--"not designed to be painful," I learned at the Adult Marketplace, "just very sensual and aesthetically attractive. The Clit Clip is a long narrow, *U*-shaped piece of metal, designed to fit around the clitoris hood, with some light-catching Austrian crystals, in your choice of clear, red, blue and purple, dangling from the ends." The woman in the elevator turns toward me and says, "Isn't it nice?" Her husband smiles proudly.

"It's charming," I reply, "but what are you gonna do if the metal detector goes off at the airport?"

I leave them giggling in the elevator as I get off on a floor where I've heard there would be lots of action. I follow one group, but only the couple in front really knows where they're going. But they happen to be on the way to their own room, and when they get there, they go in, close the door, and we are all left out in the corridor, looking like a perplexed ant farm. Everybody turns around. I am now at the front of the line, so I let them all pass by me as they head in the opposite direction, strolling briskly, except for the one-legged man with the roller skate and crutches, who is gliding gracefully along the carpet. Passersby are asked, in vain, "Where's the party?" We finally find a room with a porn photo on the door, which is slightly open.

Inside, there are around fifty people in semi-darkness. Exhibitionists and voyeurs, together again. Here a blow job, there a copulation, everywhere an undulating juiciness. There is an unspoken homophobia—no man is relating sexually to another man—but there is lots of lesbian libido. In order to keep a low profile, I have ripped several pages out of my notebook and folded them in half, so that I can take notes unobtrusively.

However, a woman with a feather duster asks me to hold on to her panties. She is about to join a threesome on the king-sized bed near the bureau that I' m leaning against. I marvel at the choreography of this foursome. But they' re playing, and I' m working. Their moans become my background music.

I wasn' t *always* a wallflower at the orgy. I flash back 30 years to 1967 . . . I was at a Sexual Freedom League couples-only party on New Year' s Eve at a large theatrical studio in San Francisco. There were about 150 people dancing in the nude. Behind the closed curtains on the stage there were fifteen small mattresses in constant use by different couples.

I remember making love on one of those mattresses with a sweet flower child only fifteen minutes after we' d met. It was an exhilarating experience. We were on the front lines of the Sexual Revolution. We had to hold back from screaming out political slogans at our moment of climax. The seeds of contemporary swinging were planted at that party, but who could have known it would blossom into an industry?

* * *

If it' s true that, as Bill Maher once stated so poetically, "The real problem with marriage is that it' s just very difficult to bump your uglies with the same person every night your whole life," then for some people,

swinging is the answer. To them, cheating is not an issue, unfaithfulness is obsolescent, and adultery is merely a concept that deprived former Air Force Lieutenant Kelly Flinn of her opportunity to drop a nuclear bomb.

The Lifestyles Convention provides a nurturing environment for these couples the same way a convention of crossword-puzzle enthusiasts or barbed-wire collectors would provide for *those* folks. Yet, in the case of swingers, one is left with a puzzle. Is impersonal intimacy an oxymoron? I ask that question of psychologist Stella Resnick, sex therapist and author of *The Pleasure Zone*. Her reply:

"We can't put a value judgment on this. These are all consenting adults. It doesn't really matter that it's rather impersonal because they are in long-term relationships, so they're getting their intimacy needs met, but not necessarily their needs for excitement in sex, and this is certainly a way to do it. Often they are sexually identified in the sense that they're sexual people, they have strong desires, they're not necessarily into politics or other causes, but this is a good cause—being in the body, being healthy—and it's a way of relaxing and enjoying their bodies. Whatever turns you on, as long as you're not doing any damage to anybody else and you're taking care of yourself, fine, enjoy."

When Tom Arnold was a guest on *Late Show*, David Letterman pressed him about his friendship with Kathie Lee and Frank Gifford. This was shortly after the *Globe* had entrapped and videotaped Gifford's extramarital tryst with a flight attendant in a hotel room. Letterman insisted, "I don't revel in the miseries of others," but Arnold reminded him of his monologues with jokes about Gifford. Letterman defended himself: "It's part of the job." Arnold stammered, searching for just the right words. He finally found them: "Frank Gifford took a bullet for a lot of us." And the audience applauded the accuracy of his assessment.

Certainly, non-celebrities don't have to worry about supermarket tabloids revealing infidelities to *their* spouses. Such exposure could never occur with swinging couples, not only because, as a rule, they are honest with each other, but also because they party *with* each other, so there are no surprises. They are sharing a secret lifestyle, one with an ethic that transcends ordinary romance. Sneaky affairs are for straight people, but swingers can eat their wedding cake and have their fantasies too. Which explains why there have been no hookers hanging around *this* convention.

Life Among the Neo-Pagans

In the summer of 1997, I performed at the 17th annual Starwood Neo-Pagan Festival in Sherman, New York—Amish country on the border near Ohio and Pennsylvania. This event—a female-oriented celebration of the sensual and the spiritual—took place on private campgrounds, where clothing was optional. Many women were bare-breasted, and several men and women walked around fully naked, a practice known as the "sky clad" experience.

Instead of camping out, I stayed at a nearby bed-and-breakfast place. Downstairs in the living room, I asked a woman—falsely assuming that she was the proprietor—where the key would be left if I came back late at night.

"I don't know," she replied. "I'm here for the festival."

"Oh. In what capacity?"

"I'm in the craft."

"Which craft?"

"That's right," she said.

She has been a Wiccan for twenty years, but now she complained, "Witchcraft has become trendy. I mean, ever since *Buffy the Vampire Slayer* . . ."

At the festival, on Merchants Row, there was an inviting banner over one of the booths: "Stop by for a Spell." A positive perspective on witchcraft was a theme at this event, along with such workshops as "Privacy Rights and Drug Policy," "Cultivating Consciousness in Your Child," "Live Meditations in Drumming and Dance," "The Supreme Court and the Free Exercise of Religion, "A Procession to Honor the Earth Goddess," "Safer Sex" and "Dark Ecstasy: The Ritual Use of Pleasure, Pain and Sensory Deprivation as Psychedelic Experience."

When I walked on to the outdoor stage, my opening line was "I' m gonna start with two words that have been *thought* year after year at these festivals, but which have never actually been uttered out loud, and those two wards are: "Nice tits." The audience hesitated a second, because in that context this could be a politically incorrect observation—I had deliberately taken that chance—but then they laughed and applauded, because they knew it was true.

I was invited back to perform at Starwood again in the summer of 1998. The previous month, two Amish men had been arrested for

distributing cocaine they bought from a biker gang, the Pagans, one of whose members was a police informer. The two men were from a particularly conservative Amish sect, where not only electricity and tractors were forbidden, but even zippers. Did the sight of those Amish-tempting zippers on the Pagans' leather motorcycle jackets serve as a gateway drug to cocaine?

Speaking of illegal drugs, at the festival I came across the only individual I've ever met who had actually hallucinated on toad slime. I pictured him as a young lad with a tadpole in his pocket, and now as a grown man with a frog in his pocket.

I also met Reverend Ivan Stang, leader of the infamous Church of the SubGenius. He talked about "how to milk the Internet for all it's worth, and get away with murder, before the Conspiracy figures out how to spoil it for us." But Stang was in deep embarrassment mode, since this was only a couple of weeks after the failure of his widely circulated prediction that, on July 5th at 7 a.m., Pleasure Saucers would descend to Earth as part of the great "Rupture" and take away all those SubGeniuses who had paid $30 for the privilege.

The festival climaxed with its traditional 50-foot-diameter, 25-foot-high bonfire, constructed during the week with the aid of a derrick. On

Saturday night, several dancers with torches ritualistically teased this pyramid of logs, encircled at a distance by two thousand enthusiasts, although one impatient woman yelled, "Just *do* it!" The neo-pagans danced and pranced and cavorted around the bonfire late into the night.

My own personal highlight occurred when a beautiful woman named Pearl approached me. She was in the process of transforming her breasts from fetish to functional by nursing a baby that had been conceived there the year before. During that festival, she had walked in on my performance, bare-breasted, at the precise moment that I uttered the words, "Nice tits." She assumed that I was referring specifically to her and, I had learned, she was flattered, so now I didn't have the heart to disillusion her. But I did write about it in my *High Times* column, "Brain Damage Control," ending with this sentence: "I hope she doesn't read this."

Furthermore, at the 20th annual Starwood Festival in 2000, I found myself in front of a microphone on that same stage, and I told that story. Pearl was in the audience, and she was laughing heartily. This time, though, when I said, "Nice tits," I added, "Okay, now *everybody*," and the words came booming back at me: '*NICE TITS!*'" Later, as I was

leaving the stage, Pearl called out, "*Nice dick!*" I was fully dressed, but it didn't matter. This was a perfect example of tit for tat. Or dick for tit.

My old friend Steve Gaskin and I were staying at a bed-and-breakfast house where there were angels all over the place. Stuffed angels, plastic angels, plaster-of-paris angels, embroidered angels, stained-glass angels, *papier-mache'* angels, teddy-bear angels and origami angels. There were angel dolls and angel paintings and angel sculptures and even an angel mobile hanging from the ceiling. In the bathroom, there was an angel tissue-dispenser and an angel night-light. On a table in the hallway, there was a pile of *Angels on Earth* magazine. On the bureau in my room, there was a copy of *Whispers From Heaven*, featuring such articles as "Feeding Angels," "When Angels Kiss" and "Rescued by Angels: The Amazing Story of a Kidnapping Survivor."

Gaskin's room had a door that led to the roof, and the first night we sat out there and smoked a joint. The next day there was a note taped to the door: "The roof is to be used only as a fire escape. Please use the patio." The next night we smoked a joint in my room. And the next day there was a "No Smoking" sign on the inside of my door, and the electric fan was on, aimed toward the now-open window.

At breakfast the next morning, I was just about to apologize to the kindly Christian woman whose home this was, explaining that a doctor had recommended marijuana for my arthritis, but *she* apologized to *me* because she hadn't told me in advance that smoking wasn't allowed. "Some people are allergic to cigarette smoke," she explained, and I almost blurted out, "That wasn't tobacco, that was pot."

I hope she doesn't read this.

Murder At the Conspiracy Convention

"The history of civilization is the history of warfare between secret societies." --Ishmael Reed

In the men's room at the airport, a man standing at the urinal a couple of urinals away from my urinal was urinating without aiming his penis. Both hands were flossing his teeth. A monument to multi-tasking. I'll admit that I occasionally brush my teeth while I'm urinating—at least that leaves me with one hand free to steer—but this guy could possibly be the only human being on earth who pisses and flosses simultaneously.

He must have practiced at home before he decided to go public. And of course he was proud of his manual dexterity. Maybe he even has a license plate that says PFLOSS, though other drivers might assume it's his name, not his avocation. In any case, that image immediately replaced my previous visual mantra: seeing one of the kids on a school bus holding up to the window a sign that read HELP US!--and laughing with his classmates.

Now, on Memorial Day weekend, I was catching a flight to San Jose, California. I was headed for Conspiracy Con 2001, a convention featuring the prophets of the sinister.

My friend Roy Zimmerman, who writes and sings satirical folk songs in the tradition of Tom Lehrer, has a spoken piece of patter which goes: "I just got back from the conspiracy convention. Have you been? It's fun. Seven hundred conspiracy theorists all in one hotel, with the little name tags, 'Hello, my name is—none of your fucking business!' Great seminars— 'Triangulation and You, 'Paranoia for Profit,' 'Victoria's Real Secret Was J. Edgar Hoover.' In the lobby, I saw five people get off the elevator—what, you think that's a coincidence? There was entertainment, of course—a group of horny anti-government folk singers called the Randy Weavers."

Zimmerman was surprised to learn that there would actually be an event such as the one that he thought he was making up. Although the real conspiracy convention didn't have the seven hundred attendees he had imagined, there were over 500, including 40% from out of state and 10% from other countries, including Canada, England, Australia, Denmark, Austria and Ireland. Also taking place at the Santa Clara Convention Center that same weekend as Conspiracy Con was the Charismatic Catholic Convention. Dueling religions, together again.

* * *

The leadoff speaker at Conspiracy Con was Cathy O' Brien, who claimed to be a victim of the CIA's MK-Ultra child-sex-slave program, Project Monarch. She was introduced by her husband, Mark Phillips, as "the love of my life." Phillips claims that, having worked for the CIA, where he learned hypnosis, and for a Department of Defense subcontractor with exposure to mind-control research, he was able to rescue O' Brien, deprogram her and collaborate on their book, *Trance Formation of America*.

"There is not one person in this audience," he exhorts, "that could not be legally experimented on, killed or financially destroyed."

He has the bearing, the cadence and the pompadour of a dramatically pious televangelist. He oozes with practiced integrity. In contrast, Cathy O' Brien has the demeanor of a guileless, bleached-blond checkout cashier in a small-town supermarket who sends money every week to her favorite televangelist. She speaks with a certain tremor in her voice.

"Mind control," she warns, "is the most important issue facing humanity today."

She reveals her relationship with Gerald Ford, who was "very much interested in mind control, so the local Michigan Mafia child pornography

ring was actually sanctioned, and they could target children like myself who were so horribly abused that they would be used in child pornography. When my father was caught sending this pornography through the mail, Gerald Ford approached and told him that he could receive immunity from prosecution if he would sell me into the project. My father eagerly agreed. He was so happy that the government actually condoned child abuse that he went on to have five more children to raise for the project, so there were seven of us in all. He was never prosecuted and remains free for reasons of national security."

At the age of 13, she met the man "who would become my owner" —Senator Robert Byrd. In *Trance Formation*, she describes their first meeting:

"I undressed and climbed into his bed as ordered. I was momentarily relieved to find that his penis was abnormally tiny—so small it didn't even hurt! And I could breathe with it in my mouth! Then he began to indulge himself in his brutal perversions, talking on and on about how I was 'made just for him' due to the vast amounts of pain I could withstand. The spankings and police handcuffs I had previously endured were child's play compared to Senator Byrd's near-death tortures. The hundreds of scars on my body still show today.

"I was one of the only kids in my school who listened to country music. But then, Senator Byrd fancied himself a country music fiddler, and it was 'my duty to love what he did.' I was ordered to listen to country music or no music at all. Music was my psychological avenue for escape, a dissociative tool. CIA operator Merle Haggard, who often used well-documented cryptic language in his songs pertaining to government mind-control slave operations, released songs including 'Freedom Train' and 'Over the Rainbow.'

"My father told me repeatedly that Merle Haggard was my 'favorite' singer, and his songs reinforced my programming. Of course, Senator Byrd remained my 'favorite' fiddler' as ordered. He played train songs like 'Orange Blossom Special' while making train sounds on his fiddle. Sometimes I was his captive audience, bound and gagged, while he played his fiddle. Other times he instructed me to spin round and round like a music box dancer in order to add 'new dimensions to our sex.' These new dimensions included more and more physical pain through 'kinky' torture."

It was Senator Byrd who directed her father to send her to Catholic school, and it was Gerald Ford who became "my first president." That night, she recalls, "I wore my Catholic uniform as instructed and went into

a dissociative trance as my father drove me to the local National Guard Armory, where I was prostituted to Ford. He took me into an empty room, pushed me down on the wooden floor as he unzipped his pants and said, 'Pray on this.' Then he brutally, sexually assaulted me. Afterward, my memory was compartmentalized through use of high voltage. I was then carried out to the car where I lay in the back seat, muscles contracted, stunned, in pain, and unable to move."

And then there was Dick Cheney, President Ford's chief of staff. After Cathy was hunted down and caught in Cheney's game of "human hunting," she stood naked in his hunting-lodge office as he paced around and gave her this choice: "I could stuff you and mount you like a jackalope and call you a two-legged deer. Or I could stuff you with this--he unzipped his pants to reveal his oversized penis--right down your throat and then mount you. Which do you prefer?"

Apparently, Cheney's oversized penis balanced out Senator Byrd's tiny penis--a tawdry version of Emerson's Law of Compensation.

Cathy specialized in political figures (although she was also thrust upon by country singers such as "CIA operatives" Merle Haggard and Kris Kristofferson). With unintentional prophetic irony, Cathy described her 1983 meeting with Ronald Reagan, George Bush and Dick Cheney:

"Reagan gestured toward Bush and said, 'This is my vice president. People don't usually know what the role of the vice president is because he's always behind the scenes making sure everything that the president wants done happens the way it's supposed to.' He looked at me and said matter-of-factly, 'I catch the public's attention while the vice president carries out orders.' 'And *gives* them,' added Bush's close friend, Dick Cheney.

"George Bush, Jr. stood by his father and covered his backside whenever Bush would become incapacitated from drugs or required criminal backup. It appeared that Junior was there to serve both purposes while his father and Cheney enjoyed their work-vacation. Junior had never shown any interest in me sexually. Like his father, he had only shown sexual interest in [my daughter] Kelly, who had been away with him most of the day."

Cathy told the Conspiracy Con audience that, at the age of 19, "I worked on a White House/Pentagon level during the Reagan/Bush years and carried out many criminal covert operations for the CIA. The war on drugs was no more than the CIA eliminating competition worldwide, turning our streets into a bloodbath. I was exposed to many drugs, perversion, sex activity, filmed through a little lens in the ceiling because

these criminals do not trust each other, so they blackmail each other. I used cocaine, sometimes heroin, Bush's drug of choice.

"Of all the drugs I was exposed to there was one that was strictly forbidden, and that was marijuana, because the effects on the brain actually opened those neuron pathways so that any compartmentalization of memory, of any kind of trauma, or so-called secret, actually begins to erode. That's why they don't want to have even medical marijuana. I'm not standing here to be pro-marijuana at all, I am here to tell you I am extremely *anti*-marijuana, but I know why this anti-marijuana campaign is out there, with their efforts to control all of us by making sure that this particular drug is controlled so that no one in any kind of position would have free thought."

When Cathy finished her presentation, Mark Phillips returned to the stage. "We ask you respectfully," he said, "to please allow us to provide you with" —that is, to sell— "our book and share it with someone you love. It's a horrible book, probably the most incredible validated story that is going to soon be a major theme in maybe more than one motion picture and a TV documentary series. After all these years, Cathy and I believe that this is our last year."

And therein lies a paradox of this convention. All the speakers totally distrust the controlled mainstream media, yet they all sense imminent triumph, believing that they and their messages will soon be vindicated by that very same controlled mainstream media.

You want statistics? Here' s what the polls show: That 68% of Americans believe President Kennedy was killed as part of a conspiracy. That 51% believe federal officials assassinated JFK. That 40% of Americans think the FBI set the fires at Waco. That more than four in ten Americans think the FBI deliberately withheld evidence in the Oklahoma City bombing case. That 80% of Americans think the government is concealing knowledge of extraterrestrial life. That 75% of Americans believe the war on drugs is a failure. That 47% of people using public toilets flush with their feet.

* * *

In a book about the National Security Agency, *Body of Secrets*, James Bamford reveals that, in 1962, U.S. military leaders proposed a plan to commit violent terrorist acts and kill innocent Americans, blaming Cuba in order to create a pretext for invading the island and deposing Fidel Castro. One document prepared and signed by all five Joint Chiefs or Staff, states: "We could develop a Communist Cuban terror campaign in the

Miami area, in other Florida cities and even in Washington. We could blow up a U.S. ship in Guantanamo Bay and blame Cuba. Casualty lists in U.S. newspapers would cause a helpful wave of indignation."

In an interview, Bamford said, "What the Joint Chiefs indicated in their plan was, they would have people shot on American streets, bombs blown up, refugee boats sunk on the high seas—and all this would be blamed on the Cuban government."

I have no problem believing such insidious intentions—certainly the U.S. military commanders were *capable* of such dehumanization—and yet I can't accept as truth Cathy O'Brien's story. I think it's an elaborate hoax, intertwining celebrity porn with historical context to foster credibility. Example: "Noriega had been an intricate part of arming the Nicaraguan *contras* for Reagan, as well as an international hub in the cocaine operations that funded the black budgets for ultra-secret projects such as Project Monarch.

"Michael Aquino put a vaginal prod in my hand and ordered me to masturbate myself with it, pushing the button to electrically jolt myself internally upon command. Noriega's eyes were enormous. He paled to a sickly grey, his mouth fell open and he ran out the door while Aquino

assured him that he had 'nowhere to run, nowhere to hide from Reagan's powers.'"

So who *is* this Aquino guy? According to Cathy, "In the early 1980s, my base programming was instilled at Fort Campbell, Kentucky, by U.S. Army Lt. Colonel Michael Aquino. He holds a Top Secret clearance in the Defense Intelligence Agency's Psychological Warfare Division (PSYOP). He is a professed neo-Nazi, the founder of the Himmler-inspired satanic Temple of Set and has been charged with child ritual and sexual abuse at the Presidio Day Care in San Francisco. But like my father, Aquino remains 'above the law' while he continues to traumatize and program CIA-destined young minds in a quest to reportedly create the 'superior race' of Project Monarch mind-controlled slaves."

I contacted Aquino, who retired in 1994, and he responded:

"Not only was I never stationed at Fort Campbell at anytime throughout my entire Army career, but I've never even visited that particular post, on- or off-duty. I have never had any contact at anytime, anyplace, anywhere with Cathy O'Brien. I have never programmed sex slaves for the government or anyone else. I have never participated in any form of child abuse whatever."

What does he think her motivation is?

"I can only assume that O' Brien is either a crank or simply an unethical individual who seeks money, notoriety and/or publicity by inventing sensationalistic lies. Her book is strewn with sex accusations not just about myself, but concerning a parade of high government officials, celebrities and country music stars. I haven' t sued O' Brien for libel for the simple reason that her book is clearly in the lunatic fringe, and to take legal notice of it would only give it a dignity it doesn' t deserve. I presume that the other public figures libeled by it haven' t sued her either for the same reason.

"I certainly am not going to defend/excuse any of the MK-Ultra projects. These were all before my time—I was commissioned a 2nd Lieutenant in 1968—and I read about such things in *Search for the Manchurian Candidate* and *Acid Dreams*, shaking my head, much the same as you probably did. I *can* affirm that my work in Army PSYOP was strictly legitimate and in keeping with the Field Manual #33-1 guidelines taught at the Special Warfare Center, Fort Bragg.

"In a nutshell: techniques for trying to convince an enemy not to fight but to cooperate with you. I originally became interested in it because (a) I believed that the USA was generally on the side of goodness, and (b) winning wars by persuasion rather than bullets and bombs seemed

a great idea to me. This may sound like a naïve idealist, but that' s the way I looked out at the world in 1968."

I asked Aquino, "Do you think that Cathy O' Brien and Mark Phillips utilized you in their book [published in 1995] because the Presidio case would give their accusations a patina of verisimilitude?"

"Well, I think that' s obvious," he replied. "After the highly publicized and sensationalized attack on my wife and myself at the Presidio, all sorts of nutcases tossed my name around in whatever their fantasy of the moment. The combination--high-ranking Army officer, intelligence officer, Special Forces officer, PSYSOP officer, #2 official of the Church of Satan 1970-75+--was just too juicy.

"As for the Presidio affair, following the publication of the 'recovered memories of Satanic Ritual Abuse' book *Michelle Remembers* in 1980, the United States and other Anglo-American countries went through a decade of 'Satanic Ritual Abuse scares and witch-hunts. After the 1984 McMartin Preschool became internationally publicized in one such scare, day-care facilities generally became targets of 'Satanic Ritual Abuse' witch-hunts.

"The epidemic extended to U.S. military services as well, including fifteen U.S. Army day-care centers and elementary schools by 1987. In late

1986 it was the turn of the Presidio. The San Francisco Police investigated, verified that my wife and I had been three thousand miles away in Washington, D.C.—where I was on duty every single day [that the alleged victim] was at the day-care center September 1st to October 31st, 1986—and closed the case with no charges accordingly.

"In October 1988, however, I appeared as a panelist on a *Geraldo Rivera Halloween Special*. Rivera was trying to aggravate and escalate the 'Satanic Ritual Abuse' witch-hunt mania, and I was speaking out against it. The broadcast came to the attention of Senator Jesse Helms who became enraged that a Lt. Colonel in the Army should dare to hold a 'Satanic' religion. As Freedom of information filings later revealed, Helms then secretly contacted his close personal friend, Secretary of the Army John Marsh, and insisted that Marsh devise some way to destroy my career.

"What was actually taking place: a blatant attempt by Senator Helms, Secretary of the Army Marsh and the Criminal Investigation Division of the Army to discredit an Army officer with a 'politically incorrect' religion. It didn't work."

* * *

Although I believe that *Trance Formation of America* is an elaborate hoax and Michael Aquino thinks it' s in the lunatic fringe, conspiracy researcher Robert Sterling perceives a more devious motivation. In *Apocalypse Culture II*, edited by Adam Parfrey, Sterling writes:

"Effective disinformation is never an absolute lie. The purpose of disinformation is to confuse truth and validity, and to do so, boldfaced les are rarely convincing. Effective disinformation mixes truth and deception to obfuscate the two. The closer the disinformation approaches truth, the more damning it becomes. Then all the disinformation, even the legitimate parts, discredits targeted research and ideas.

"At the time of the release of *Trance Formation*, there was a growing awareness in the conspiracy subculture of intelligence agency involvement in satanic ritual abuse. Literature on the subject was reaching a critical mass where it could not be ignored. Would intelligence agencies devote resources to counteract such information? Not only is it possible, it almost certainly has occurred.

"The CIA, even with an officially acknowledged history of abusing people through mind-control experiments (the most famous being MK-Ultra), certainly has a vested interest in denying such operations exist, especially when the operations are as insidious as sexually abusing

children. And supposing that [the] tales are part of a CIA disinformation campaign, it would make sense that some names on the list would actually include guilty participants. After all, what better place to hide the truth than out in the open, knowing full well it won't be believed?"

Sterling posted a review of Cathy O'Brien's book by Jaye Beldo on his Web site, *The Konformist*:

"If you are bored out of your mind with the usual Pamela Anderson Lee 'power-fuck porn,' I suggest grabbing a copy of *Trance Formation of America* and heading to the nearest bathroom with a jar of Vaseline. Why not infuse life into your worn-out sexual fantasies by envisioning some of the scenes spelled out in Cathy O'Brien's supposed expose' of the pedophile shenanigans of our Government officials? I mean, how could you not get excited over picturing Hillary Clinton going down on the author's deformed vagina like a starved wolf while Bill walks in on them and casually ignores them?

"I cannot help but get the impression that Cathy is, at times, really no different from some of the questionable UFO abductees making extravagant claims of being transported to other solar systems and back again. I have little doubt that some of the horrible things she mentions

actually happen on a day-to-day basis. Completely denying them would be folly."

Mark Phillips was not too thrilled with this review, and he wrote to Beldo:

"I feel compelled to inform you of the inevitable consequences of your unsolicited written vulgar assaults upon Cathy O' Brien, Kelly, myself and the overall integrity of our book. I have placed you on the shortlist of potentially dangerous sexual predators, which is automatically reviewed by interested local law enforcement personal [*sic*] (that we are in regular professional communications with) whenever a sexual crime is committed in the area you reside. Until you are apprehended for being a physical threat to yourself and/or innocent others, you will remain at large but nevertheless well identified.

"Stay away from contact with children and out of any county/state/federal prison system, as within moments from the time you may eventually be arrested for some alledged [*sic*] charge of illegal/immoral activities, I will be notified and will do all in my power of influence to see that you are legally seperated [*sic*] from society until you have had to time necessary to do what you proposed for others less appreciative of your sick 'review'—to get a hold of yourself or allow an

inmate to take matters into their own hands and change your thoughts towards acceptance of brutal criminal activity."

Konformist editor Sterling wrote to Phillips:

"I harbored no personal animosity to either you or Ms. O' Brien, but I had serious questions about the accuracy of what was in your book. Even more disturbing, I had a very bad feeling that, wittingly or not, the claims in *Trance Formation* could easily be used to manipulate people into a hysterical witch-hunt state, and could be used to smear those who are innocent of charges made by you and Cathy, Brice and others. I felt if people were not careful, they could be whipped into a fascist state of mindlessly agreeing to any charge made by alleged CIA sex slaves to a conspiracy underground version of McCarthyism."

The "Brice" he refers to is Brice Taylor, author of the first competitor of *Trance Formation*, published in 1999—*Thanks for the Memories: The Memoirs of Bob Hope's and Henry Kissinger's Mind-Controlled Slave*—in which she asserts that Walt Disney raped her on Mr. Toad's Wild Ride; that she had sex with all three Kennedy brothers plus JFK, Jr. when he was 12; and that she has cavorted with public figures ranging from Prince Charles to Alan Greenspan, from Elvis Presley to Neil Diamond, from Johnny Carson to Ed McMahon. "Hi-yo!"

Brice Taylor also claims the existence of a federal program of brainwashing and molesting children with electroshock and dolphins, that she and her 13-year-old daughter had a threesome with Sylvester Stallone, and that he filmed them in *Dolphin Porn*, videos of dolphins penetrating women in the ocean. And Cathy O' Brien declares that "Jesuit/NASA-based whale and dolphin programming suggests that water is a mirror to other dimensions and is the means by which aliens have mixed with our population."

Robert Sterling observes that, "After suffering horrible torture and abuse at the hands of countless famous politicians and celebrities, both O' Brien and Taylor declare of being spoken to by Jesus Christ, whose glorious powers healed them of all trauma and left them immune to further manipulation. At the time of her 'memory recovery,' Brice was corralled and influenced by Christian fundamentalists, who convinced her that her previous life was the prelude for an afterlife in Hell. It should be obvious that the New World Order sex slave genre is nothing more than thinly veiled porn disguised as parapolitics."

Sterling told me that Cathy and Mark' s book has "sold over 20,000 copies. Their following is heavily right-wing Christians and patriot groups, and if you hang out with either sector you' ll eventually hear

some pro-*Trance-Formation-of-America* sentiments. Not surprising—part of the book's thesis is that mind control is part of the New World Order plot."

The predecessor of this whole non-literary genre was *The Control of Candy Jones*, published in 1976. Jones was a highly successful model supposedly transformed into a CIA Manchurian Candidate. The book was ghostwritten by her husband, a carnival hypnotist and late-night radio talk-show host "Long John" Nebel. His friend, stage magician and psychic debunker James "The Amazing" Randi, told me that Nebel made up the entire book because he needed money. When I mentioned this to Walter Bowart, author of *Operation Mind Control*, he insisted that Randi himself was an intelligence agent. Amazing, indeed.

* * *

There's a mini-ballroom at the Convention Center where conspiracy books, audio and videotapes are being sold. A man wearing a space suit is hawking an Alien Abduction Survival Kit. Another vendor is selling aura cameras. And, for some incongruous reason, a woman is coning—that is, getting the wax out of a prone client's ears with the aid of a burning candle and a tin pie-pate. At a booth offering "Free

Electricity for Life," the proprietor is saying, "They killed one of my associates."

In the auditorium, William Lyne, a researcher on free energy devices for 50 years, tells the audience, "I know a man who's in mind control—and they've used it on him and his father—they use a virtual reality type of technology that's projected to that person, transmitted to them so that they see images that aren't there, but what they want to do is terrify them and make them *think* they're seeing these things, except they're intelligent people and they know that they're not real images, they just want to know how they're *receiving* those images. If they want you to see something, they can transmit it to you.

"They can do it for a whole area. And the place where this person lives, they're all shutting down at 10 o'clock at night. Everybody in that whole part of town are actually going to bed at the same time. It's like they've got the whole area under control. And it's within eyeshot of Los Alamos Labs. The dirty part of the labs where they do this kind of stuff. I say dirty because there's coerced black projects being done out of there."

As for Lyne's own safety in the face of promulgating free energy, he says, "I'm encouraged lately because there's safety in numbers. Too

many people have access to this stuff and are promoting it. Now there have been some real tragedies in the past. People had some of this technology and they disappeared or were squashed. I don't have any fear of the government. I lost my fear a long time ago. They tried to murder me several times, and I said to myself, 'Well, I might be dead tomorrow and nobody'd know why, so I'm gonna go out there and tell what I know and I'm not afraid,' and I think everyone should take the same approach."

Jordan Maxwell has been exploring the hidden foundations of religions and secret societies since 1959. At the convention, his presentation is titled *Toxic Religion and the Occult Establishment*. "The same people who gave you the Mafia gave you the Church," he says. "The Church *is* the Mafia. An FBI man called me: 'We've been watching you, we follow you wherever you go, we know what you're doing. But you are not a threat. We admire what you're trying to do. But your government does not consider you to be a threat—yet—but if you get enough people listening to you—and they're not just listening but they're actually *hearing* you—then you will be considered a threat and now we'll have to take another look at what you're going to do.

" 'But the reason I' m calling—this an unofficial call—is to warn you when you talk about corruption and government, most people in government couldn' t care less, they don' t care, they' re corrupt and they know it and you know it, so what are you gonna do about it? But when you talk about the Church and religious institutions in this country, what you' re doing is you are messing with organized crime at its highest level. The highest levels of organized crime in this country are the religious institutions. We' re talking about a lot of money. We' re talking about the control of men' s minds, about the dream of absolute total domination. This makes the Mafia look like child' s play.' "

Another speaker, Len Horowitz, author of *Emerging Viruses: AIDS and Ebola*, explains that "Non-lethal warfare is where you don' t kill populations like with a bomb or a gunshot, but you make them sick. You make them dependent on pharmaceuticals which are actually a military-pharmaceutical complex run by the same players—the global elite—and then ultimately these populations become enslaved to the pharmaceuticals and economically debilitated along with their nation states."

Now, like the Blues Brothers, he on a mission from God: "Bust the Illuminati. Bust the cryptography code. The darkest time in our history is just beginning. Revelation tells you in God' s word that you and I should

count the number of the Beast 666. The revelations we've just been given is that wisdom. It takes it out of the realm of foolish conspiracy theory into hard, provable, scientific, statistically significant fact, and God bless you with it at this time. With that blessing, I want to thank you so much for allowing me to be here tonight [it was now 12:30 in the afternoon]. Thank you. God bless you. Thank you [said nine times]. Say hallelujah! Praise God! Thank you all."

Dr. Horowitz was scheduled to fly to Africa and spread the word. "Okay, God," he prayed aloud, "if it's not Your will for me to go—because apparently I'm hearing from all these people that I shouldn't go, I shouldn't go, fear, fear, fear, fear—please let me know what You want me to do, and if You have me go, if You choose to have me die if I go, then so be it, but I would prefer to live and carry your work forward, so please direct me." And of course God told him to go.

Yet another presenter, William Thomas, author of *Chem-Trails: Mystery Lines in the Sky,* also revealed a sense of his own martyrdom. He stated that "The earth and its inhabitants are being subjected to unprecedented experimentation without our knowledge or permission. Some say the chem-trails are intended to kill us all. Others insist the disorientation and lethargy resulting from chem-trail exposure are

intended to make citizens compliant to the New World Order and enslave us all.

"The most plausible explanation for massive aerial spraying is a planet-wide, high-tech campaign against catastrophic climate change. If true, such a desperate Band-Aid solution disregards fundamental causes of global warming in order to protect powerful financial interests by permitting pollution and profits. This story has cost me a lot--cost me the love of my life, my career. To the people doing this, you can break my heart and you can break my back, but you will never, ever, break my spirit." [Prolonged applause, shouts of *Bravo*] "I' m not afraid of death."

And the P.A. system blared forth the sound of Jackson Browne singing, "There are lives in the balance . . ."

* * *

If there is a star of this show, it' s David Icke (rhymes with bike). Author of *And the Truth Shall Set You Free*, he' s a dynamic performer, somewhat pot-bellied, with longish yellow hair. His presentation is about the secret manipulation of the human race, going back thousands of years, revealing how the same interbreeding bloodlines continue to control positions of power today, and he ardently shares suppressed information

on humanity's ancient extraterrestrial origins. Thus he offers an alternative explanation of our existence that transcends creationism and evolution alike.

All that, and he puts his underwear on backwards too. With his whimsical British accent, he confides to the audience: "A little while ago, I'm thinking I'll empty me bladder before I speak, so I'm fiddling and I can't make contact, and then I realize I put me underpants on the wrong way around. I didn't know whether I was coming or going." Then he entered specific domains of strangeness:

"A few years ago, I met a scientist who joined the CIA as a youngster, serving his country. He is a genius in the area of magnetics. When he started to work for the CIA in these secret projects, he realized that they didn't want his knowledge to serve humanity, they wanted to create technology that would help to control the mass of the population, and he rebelled against it and said, 'I'm not doing this any more.'

"He started to tell me a story and, as he did, he was opening his shirt. One day he left home and he started missing time. Doesn't remember anything about it. But he does remember waking up on a medical-type bench, and as he got his faculties back he realized there was

something stuck to his chest. As he opened his shirt, I could see like a see-through shampoo sachet on his chest with an orange-gold liquid inside it.

"And he said that what they' d done was manipulate his body to need this drug to survive, and if he doesn' t get it, then he starts to die what is apparently a very long and painful death. And this patch--which is what they call them on the inside--with the drug has to be replaced every seventy-two hours, and if he doesn' t serve an agenda that sickens him, then it' s not replaced.

"He told me about a microchip now so small it can be inserted in a vaccination program through a hypodermic needle. Even those who thought the microchip was coming along as a tagging device have not realized that it' s not just about keeping a tag on where people are. It' s not actually the signals going from the chip to the computer we should be concerned about, but the signals coming the other way *to* the chip, because the technology exists, outside the public arena and increasingly in it, which can manipulate human emotion and thought processes externally once one of these guys is inside. If people say no to one thing, say no to the microchip."

(In December 2001, Reuters would report that a chip the size of a grain of rice which can be injected into your body and give detailed

information to anyone with the right scanning equipment is soon to be available from Applied Digital Solutions. The company has projected a potential market worth $70 billion.]

Occasionally, Icke throws in a tidbit of comic relief, such as two Martians in a bar: "Have you heard the latest about the Earthlings?" "No, what have they done now?" "They borrow money that doesn't exist and pay interest on it."

Other times, he'll throw in a generally unconsidered theory: "JonBenet Ramsey has all the feel of her being a multi-personality, dissociative identity disorder, trauma-based mind-control situation, and involved in satanic ritual abuse. I think there's a massive cover-up there, because if you're going to stop the dominoes falling, you have to stop the first domino falling, and that's what that cover-up to me was all about."

But he is most challenging when he discusses interbreeding: "Why are three ruling families today obsessed with interbreeding? Why when you follow them back genealogically to the ancient world have they always been obsessed with interbreeding? I found an amazing common theme in the ancient world anywhere on the planet—the theme of gods

interbreeding with humanity, creating hybrid bloodlines which ended up in positions of power.

"I talked five hours with a Zulu shaman about extraterrestrial connections to the Illuminati. African history is the same theme, of gods from another world, which have great connections to earth history, interbreeding with humanity, creating bloodlines which have ruled the world all these thousands of years. The royal black bloodline of Africa from the age of tribal days claimed descendants from the same gods that these other crowds do.

"One of the great themes that comes up in this interbreeding and these ancient accounts is of a serpent race, a race of a reptilian genetic history, which interbred with humans, creating hybrid DNA. I' m not just talking about this tiny frequency range we call the world. There are other frequencies as well, in terms of where manipulators of the manipulators actually come from. This force which manipulates through these bloodlines overwhelmingly operates right on the periphery of our physical senses, right on the edge. It can appear that someone' s gone from one form to another. This is 'shape shifting' between human and reptilian form.

"From 1998 onward, I kept meeting people telling the same story, that they have seen people overwhelmingly in positions of power--but not

always--move from a human form to a reptilian-type form. There is the Mayan legend of the iguana. Lizard-like aliens had descended upon the Mayans. Their pyramids—their advanced astronomical technology including the sacrifice of virgins—were supposedly inspired by lizard aliens. When the aliens interbred with the Mayans, they produced a form of life they could inhabit. They fluctuated between a human and iguana appearance in chameleon-like abilities, a perfect vehicle for transforming into world leaders.

"Those who have seen a reptilian-type ethereal figure enveloping and following around humans and locking into them in those lower two chakra points, vortex points, for me, is possession. The more I' ve understood this, the more I' ve realized just how many people, particularly these bloodlines, are actually controlled by these other-dimensional forces, and while we appear to be seeing a president or a banking leader in a physical form, the actual point of control is beyond that and overshadowing it, and on some occasion people see that overshadowing entity."

One wonders whether such a defense— "The reptile made me do it!" —will some day be used in a court of law.

"To understand humanity," Icke continued, "you have really got to understand humanists reptilian past, reptilian inherited genetics. One of the most ancient parts of the human brain is known by science as the R complex, for reptilian brain. We get these traits—cold-blooded behavior, ritualistic behavior, desire for top-down power over structures. Now, dismiss the reptilian thing—let's just think they don't exist—I have just described the basic mentality of the Illuminati that allows wars to be created, millions of casualties without any emotional attachment to consequences. Why do people who have more money than they could spend in a thousand lifetimes go on accumulating it? Why do corporations that have *enormous* power and control over vast areas go on accumulating and seeking more and more power and control?"

So, then, is this whole reptilian agenda really just a metaphor for the varieties of human cruelty? Or does Icke mean it all literally?

Previously, Jordan Maxwell had told the audience, "I think the dirtiest, the filthiest, the most licentious people on the face of the earth are the British royalty. They represent in the human race all that is evil and all that is filthy and degenerate. And that's why Princess Diana is dead." That there was a conspiracy behind Diana's death seems to be a given among this crowd: the royal bloodline protected by the paparazzi.

Conspiracy researchers often start with a premise—who benefits?—and work their way backward, molding their perception of reality like Silly Putty in order to *culminate* with the justification of that premise.

Maxwell continued: "About ten years ago, a young black man broke into the Queen Mum's bedroom, and one of her servants happened to be walking by and the bedroom door was open a bit, and she saw this young black boy in the queen's bedroom. She quietly went to security which came up and arrested him for breaking into the queen's bedroom, but the queen said he didn't threaten her and he wasn't armed and it was just a childish silly prank, and so she let it slide if he promised not to do that any more. James Bond couldn't break into the queen's bedroom! If there was a young black man in the queen's bedroom in Buckingham Palace, the queen ordered him in like pizza. The Queen Mum with her black boyfriend. Tell me about racism."

That anecdote says something about the queen's human nature, but now David Icke added another dimension:

"Some of the descriptions, like of the British royal family—people who claim to have been at the rituals—are of a *literal* shift. They seem to go from one physical state to another, very much in this dimension, which from our perspective of this-world physics is like, *what?* And then others

are describing what appears to be a vibrational thing, where people are looking into another dimension slightly outside of our physical frequency range, the normal one, and suddenly they're seeing another level of the person which appears reptilian. And exactly where the truth is in all that or whether it's a shade of grey and both are true, there's a lot more information that is needed.

"Going back in African history, this reptilian group actually go back a phenomenal amount of time in relation to this planet, and they claim that it's actually rightfully theirs, and at some point in the ancient past there were some great wars that went on, and in fact they were kicked off, and they're trying to regain control of what they think is rightfully theirs, like being kicked out of a country.

"Other researchers, concentrating on the reptilian thing for a long time, say that in some way they basically go around to different places, just raping the resources, and then move on. Then there's the one about the fact that in some way a lot of these beings were almost imprisoned, in a vibrational prison, like they can't get out of it by going up because they can't vibrationally get there in their present state of being. And their only way out of that level is to come into a lower level of vibration into this

dense physical world, and operate through that. But I understand Cathy saying it' s only a mind-control thing."

From the gospel according to Cathy O' Brien:

"When Bill and Bob Bennett together sexually assaulted my daughter Kelly and me at the Bohemian Grove in 1986, I had already known Bill Bennett as a mind control programmer for some time. He apparently found perverse pleasure in whipping me. With my wrists bruised and my body stinking with pain, Bennett lit up a cigarette and cryptically asked, 'Was that your first cum-union with an alien?'

"[On another occasion] deep underground in NASA' s Goddard Space Flight Center mind-control lab near D.C., Bill Bennett began preparing me for the program. NASA uses various CIA designer drugs to chemically alter the brain and create exactly the mindset required at the time. I could barely crawl up onto the cold, metal lab table as the drug took effect in the darkness surrounding me, I could hear Bill Bennett talking. 'My brother Bob and I work as one unit. We are alien to this dimension—two beings from another plane.'

"The high-tech light display swirling around me convinced me I was transforming dimensions with them. A laser of light hit the black wall in front of me, which seemed to explode into a panoramic view of a White

House cocktail party—as though I had transformed dimensions and stood amongst them. Not recognizing anyone, I frantically asked, 'Who are these people?'

" 'They're not people, and this isn't a space ship,' Bennett said. As he spoke, the holographic scene changed ever so slightly until the people appeared to be lizard-like aliens. 'Welcome to the second level of the underground. This level is a mere reflection of the first, an alien dimension. We are from a trans-dimensional plane that spans and encompasses all dimensions. I have taken you through my dimension as a means of establishing stronger holds on your mind than the earth's plane permits. Being alien, I simply make my thoughts your thoughts by projecting them into your mind. My thoughts are your thoughts.' If this were so, why did he have to *audibly* tell me?"

Aha! A touch of skepticism from Cathy. And yet part of me still hopes that was all true, if only because of Bill Bennett's personal maxim: "Hypocrisy is better than having no values at all."

* * *

How could I distinguish truth from lies if truth was cross-fertilized with greed, the need for attention, false memory, speculation, fantasy, self-

delusion and intentional propaganda? I contemplated the implications of something that Michael Aquino had told me:

"Part of what we learned in PSYOP was that it's not just the propaganda you create that is a factor, but the pre-existing propaganda 'filters' in target audiences' brains as well. The key has to be designed to fit the lock, so to speak. And underlying all this is the challenge to the PSYOPerator to extricate *himself* from his own filters--otherwise he will see the situation only through his personal distortions and thus be inept at influencing it objectively and comprehensively."

Consequently, propaganda can become a two-way street. For example, Cory Hammond, former president of the American Society of Clinical Hypnosis, has had many clients who, under hypnosis, "remember" hideous incidents of satanic rituals, infant sacrifice, sadomasochism and coprophilia (get that shit-eating grin off your face). Dr. Hammond believes that three groups working together—neo-Nazis, the CIA and NASA—have been programming American children for over fifty years to make them part of "a Satanic order that will rule the world."

Likewise, the war on drugs is filtered through a *mass* of distortions. In the words of *The Economist*—a venerable British newsweekly that has been a longtime passionate advocate for the legalization of drugs—the

growing, selling, consuming and outlawing of illegal drugs around the world is a complex mix of economics, politics and world culture.

There are silly conspiracies. Some folks believe that the moon landing was faked (those were close-up photos of oatmeal). Others believe that the Woodstock Festival never occurred (it was contrived by the media). Still others believe that Elvis Presley's death was fabricated (he's alive in Las Vegas, working as an Elvis impersonator). And surely there must be others who are convinced that militant vegetarian activists are responsible for Mad Cow disease.

Sometimes silly conspiracists get results. In 1995, Indiana transportation officials were forced to alter the maintenance codes marked on the back of highway signs because some state residents were convinced that the markings were coded messages designed to assist invading UN troops.

And there are serious conspiracies. Gasoline refiners conspire to limit supply and fix prices. The relationship between doctors and pharmaceutical companies is blatantly conspiratorial. Douglas Valentine wrote in *The Phoenix Program* (about the CIA's notorious terrorist campaign against Vietnamese villagers) that in 1968 the Army's 111th Military Intelligence Group kept Martin Luther King under 24-hours-a-day

surveillance. Its agents were in Memphis on April 4th and "reportedly watched and took photos while King's assassin moved into position, took aim, fired, and walked away."

World War II was racketed by presidential conspiracies of silence: Franklin D. Roosevelt knew that Japan was going to attack Pearl Harbor; and Harry Truman knew that Japan was about to make peace overtures but he nevertheless ordered that atomic bombs be dropped on Hiroshima and Nagasaki. Domestically, the Aryan Republican Army financed and helped to stage the Oklahoma City bombing, and the Bureau of Alcohol, Tobacco and Firearms knew about it three weeks before it happened.

Pokeman has become a target of religious leaders throughout the Arab world who charge that the game promotes theories of evolution, encourages gambling and, at its core, is part of a Jewish conspiracy aimed at turning children away from Islam. To David Icke, Jews are the pawns in an elaborate Rothschild-Illuminati breeding experiment, and they are "impregnated with a reptilian genetic code."

* * *

There's a final panel at Conspiracy Con with questions from the audience. A reporter for *Stuff* magazine waits his turn on line, then steps up to the microphone and asks, "What is the secret to how you've

managed to maintain such healthy heads of hair? The answers: "Well, mine's glued." "I stopped pulling it out a few years ago." "It was the fluoride." "Mine is the same color when I purchased it." And, "Genetics."

A woman who claims to be a victim of mind control asks, "How do you function? How do you deal with manipulation in your personal lives, being individuals that are speaking out? Is there any secure communication? Can the whole body be scanned for implants, inside your teeth or your skull?"

Icke responds: "No technology exists in this frequency range more powerful than the human mind in its true power. When disconnected from that, we become open to technical manipulation. Is there any secure communication? I don't give a shit. I say what I think on the Internet. I don't worry about being harmed. If you don't allow the idea of vulnerability into your reality, it cannot manifest. If it's not your reality, you cannot project it. It never occurs to me that these guys can do anything to me.

"Those that were doing this [work] in fear of consequences were getting them. 'I don't know how long they're gonna allow me to do this.' They almost wore their bravery like a war medal. Courage is

overcoming fear. If you don't have fear you don't need courage because there's no fear to overcome. You just do it, get on with it, do what you believe to be right without the need for courage because there's nothing to overcome.

"'I'm doing dangerous things,' they say, 'but I keep on going. I'm sure they're gonna do this to me if I keep on.' They will get the consequences, and others who are just *doing* it, won't. And because we create our own reality, what we allow into our field of possibility can manifest. If it doesn't come it, it cannot manifest. I don't worry about defending myself."

Suddenly, as if on cue, an agitated man brandishing a pistol stalks out from the backstage area. Shouting, "The China card will be played big," he aims his gun at Icke, who sits there calmly while the other panelists all duck under the table. A single shot rings out. Panic fills the air, and screams emanate from the audience. But it's the would-be assassin, not Icke, who is the one that falls to the ground. The panel discussion has ended, and the auditorium is cleared.

I show my press credentials to a security guard and he allows me to stay. I can see a doctor hovering over the man, who is bleeding fiercely. When the doctor unbuttons the man's shirt I notice that on his chest, just

a couple of inches from the gaping wound, there is a patch with an orange-gold liquid inside it. The doctor pats it gently and says, "What the hell is this?" The man is able only to whisper, "He blew my goddam cover." Then he gasps for breath. The doctor says he's dead, and the security guard tells me I have to leave.

I had been looking forward all day to a room-service dinner of Colossal Pacific Coast Prawns simmered in Thai curry sauce with sticky rice and toasted coconut, but now I wasn't hungry. I was too preoccupied with what had transpired that evening. I kept asking myself, "Who shot the mad scientist? And why?" I felt like a poker player who's been dealt a hand of all blank cards.

Finally an epiphany arrived, and I knew exactly what I had to do. I made three phone calls, then went down to the bar to keep an appointment with David Icke that we had arranged early in the day. We selected a corner table, I took out my cellphone, dialed my own number at home, and when the answering machine started, I dialed the code to get my messages and handed the phone to Icke. This is what he heard:

"Hi, this is Paul, calling myself. I've already left a message on [my wife] Nancy's answering machine, asking her to save this tape in case anything happens to me. About the shooting that took place here, I called

my contact in the CIA who informed me that it was a Company job. They killed David Icke's friend before *he* could kill Icke. But why would they be *protecting* Icke? You'd think that they'd *want* him dead because he knows too much. Unless he happens to be one of *them* and they need him to continue spreading *dis*information. So now that this precaution has been taken, I will go and confront Icke."

He laughed.

"Nice try," he said. "First of all, don't worry, nothing's going to happen to you. But, by all means, keep that tape as a souvenir. You're right about one thing, though. I *am* protected by the CIA. Not because I'm one of them, but because I'm *not* one of them. If they wanted me dead, they could kill me any time they wanted. But they know I'm not spreading disinformation. You have to understand, these guys work strictly on a need-to-know basis. So it's not that I know too much, it's that *they* don't know *enough*.

"Because, if an individual agent knows too much, he may not do what he's been assigned to do. He must have a given order to do something, but if he knows that the end result is that somebody's going to be blown up twelve miles away—and all he's supposed to do is deliver an envelope—he may start thinking about it. So, various agents read my

books and check my Web site and show up wherever I speak. It's a safety valve for them, on how far things are going."

"Are you saying that the intelligence community has allowed you to function because *you* know more than any of *them*?"

"Exactly . . ."

* * *

On my return fight the next morning, I found myself reminiscing about the 1987-88 TV season, when I had been a writer and on-air commentator on *The Wilton North Report*, a nightly satirical hour on the Fox network that lasted only 21 shows. Critics blamed the hosts, a pair of disc jockeys who were not untalented but who were deliberately chosen for their inoffensiveness.

I had previously suggested as host Conan O'Brien, a writer on the show who also did the audience warm-ups. "No," said the producer, "he's not professional enough." Ellen DeGeneres? "Too dykey." Chris rock? "Too raw." Rosie O'Donnell? "Who wants to look at her every night?" Richard Belzer? "Too reptilian." Belzer is a conspiracy researcher as well as a comedian and actor, but little did he ever dream that ultimately he—his reptilian self—could be the culmination of his own investigation.

Now, back home, the marketing of conspiracy was on a roll. *Majestic*, an interactive computer game revolving around a conspiracy involving corporate intrigue, was available. For $10 a month, tens of thousands of online players would receive screaming phone calls at midnight, faxes, anonymous emails and instant messages from mysterious informers directing them to research strange alien conspiracies and nefarious government activities. *Majestic* was suspended on September 12, 2001.

The invasion of the United States on September 11th was the mother of all conspiracies. Immediately there were those who began spinning scenarios of an inside job, an American version of the Reichstag Fire, carried out in order to justify the rise of a police state in the guise of security procedures. In any case, political opportunism has been providing the same results.

That Halloween, I was invited by producer Andy Meisler to be a panelist at the taping of a new TV series, *The Conspiracy Zone*. Although the plot behind the 9/11 terrorists was certainly a topic of conversation in the Green Room— "Do you think this is the endgame?" --the official subject that evening was the assassination of Robert Kennedy in 1968.

On the program, hosted by former *Saturday Night Live* cast member Kevin Nealon, I mentioned that Kennedy had once been on the *Tonight* show, telling Johnny Carson that cigarettes kill more people than marijuana, and I speculated that Sirhan Sirhan was a hired gun for the tobacco companies. On a more literal note, I talked about the ballistics Inconsistency; a total of ten bullets was found, though Sirhan' s gun could hold only eight.

And I discussed the fact that psychiatrist Bernard Diamond described in *Psychology Today* how, during the trial, post-hypnotic suggestion was used to program Sirhan into climbing the bars of his cell like a monkey. However, in the book *RFK Must Die*, Robert Kaiser, who was there, wrote: "Sirhan had no idea what he was doing up on the top of the bars. When he finally discovered that climbing was not his own idea, but rather Dr. Diamond' s, he was struck with the plausibility of the idea that perhaps he had been programmed by some else, in like manner, to kill Kennedy."

There were two others on that TV panel, plus a separate segment with a dentist who practices hypnosis.

One panelist was Michael Ruppert, a former member of the Los Angeles Police Department, Narcotics Division, who became a prolific

conspiracy researcher. Off camera, I asked what the turning point had been for him. He said that it was when his fiancée, a CIA operative, tried to involve him in drug smuggling, and he refused. Ruppert and I were both columnists for *High Times* then, but, he told me, "I don't smoke grass."

The other panelist was scheduled to be former Nixon speechwriter and now bespectacled, drone-voiced personality Ben Stein, but he canceled out at the last minute. Ann Coulter, former Justice Department attorney and Senate aide, now a professional reactionary and Stepford pundit, was at the studio for a subsequent taping about secret societies, and she was drafted into taking Stein's place. A frequent guest on talk shows, Coulter is recognizable by her long blond hair, her short black skirt, and her drag-queen aura.

When she was a guest on CNBC's *The Big Idea*, host Donny Deutsch asked her what an ideal country would be like, and she replied that it would be one in which everybody was a Christian. "We just want Jews to be perfected," she said. As for Muslims, two days after the terrorist attacks on 9/11, she wrote in *National Review Online*, "We should invade their countries, kill their leaders and convert them to Christianity." But now, the taping of *The Conspiracy Zone* had to be delayed because she was still in the makeup room.

"It takes a long time to turn Ben Stein into Ann Coulter," I explained.

During a break in the show, I suggested to her that the labels "conservative" and "liberal" had become obsolescent, and I asked what she thought might be appropriate substitute labels.

"Americans and cowards," she said.

"Yikes," I replied.

On another occasion, I got a call from *Conspiracy Zone* producer Andy Meisler. The show was featuring debates about cover-ups, ranging from Freemasons to bar codes to Hollow Earth. "The frightening thing," he observed, "is that life is so *random*. At least there's something comforting about conspiracies." He was calling me for recommendations as to who might be appropriate to appear on programs about the fix behind professional sports and the fix behind the election of George Bush. (The latter topic was discarded after 9/11.) He told me that the show would also deal with "unexplained deaths," such as Jimmy Hoffa, Marilyn Monroe and the Kennedys.

"Oh, that's so last century," I said. "Conspiracy research has evolved from 'Who Killed JFK?' to 'Who Fucked a Lizard From Outer Space?'"

One other thing. My visual mantra of the man who urinated and flossed simultaneously was replaced by a patriotic image of Cathy O' Brien: "I was ushered away from my classmates," she said, "and taken to an office where Michigan State Senator Guy VanderJagt was waiting with soon-to-be-president Gerald Ford. They laughed as he placed a small American flag in my rectum and instructed me to wave it." Like all politicians, though, Ford merely *wrapped* himself in the American flag.

Swimming in the Dead Pool

When Ken Kesey's son Jed was killed in an accident--the van carrying his University of Oregon wrestling team had skidded off a cliff--I immediately flew to Oregon. "You were his favorite," Kesey said as we embraced, sobbing. "I feel like every cell in my body is exploding,"

A few days later, several of us old friends were sitting around the dining-room table there, and someone mentioned that the Dead Kennedys were on tour.

"I wonder if Ted Kennedy is gonna go see 'em," I remarked.

Kesey, standing in the kitchen, responded, "That's not funny."

"You're right. I apologize. It's not very abstract right now."

"It's *never* abstract."

I recalled that little dialogue as I began to explore The Game, now in its 34th year [2004], the longest-running dead pool in America, currently with 125 players. Before January 1st everyone submits 68 names of people who might die that year. (Dr. Death, co-founder of The Game, liked to work on a legal pad--34 lines, two columns, hence 68 names.) Points are awarded according to the age of each dead person--anybody in their 50s is worth five points; 60s, four; 70s, three.

Each participant gets one wild card per year worth five points no matter how old the deceased. Gamesters generally pick one-pointers for their wild card to get four extra points. Last year, most picked Bob Hope. When he died, one Gamester said, "My father was shot during World War II. While recuperating in England, Mr. Hope came up to his bedside and stuffed a half-dozen golf balls into his [own] mouth. It cheered my old man up."

Deaths become official when mentioned in the *New York Times* or any two major newspapers. One player "is extremely frustrated," I was told. "He has Idi Amin, who is on life support in a Saudi hospital. Now there have been death threats, and armed guards have been posted." Since the listees are all on various rungs on the ladder of celebrityhood, The Game is understandably rife with abstraction.

"After all, the dead pool has probably been around since the phenomenon of fame itself," write Gelfand and Wilkinson in the book *Dead Pool*. "It has certainly been around as long as gallows humor has. In the heyday of hard-boiled journalism (the *Front Page* days of the 1930s), reporters who covered a country ravaged by organized crime and engaged in a world war found respite in the dark humor of the dead pool. Even

before the Internet, the dead pool was slowly emerging from the shadows of our culture."

As with dead pools, ranging from business offices to Howard Stern's radio show, that book is a guide to profiting from money bets. But members of The Game play solely for the fun of it. Whoever has the most points at the end of the year wins-- "bragging rights only" —slightly ironic since Gamesters (lawyers, ad people, educators, psychology professors, writers, everyday working folks) all play under aliases like Frozen Stiff, Fade to Black, Worm Feast, Decomposers, 2 Dead Crew, Johnny B. Dead, Wm. Randolph Hearse, Daisy Pusher, Silk Shroud, Necrophiliac Pimp, Legion of Doom, Gang Green, Habeas Corpse, Die-Uretic, Shovelin' Off, Blunt Instrument, Rig R. Mortis, Flatliners, Unplugged, Toe Tag, Clean Underwear and Gratefully Dead.

One couple, the Moorebids, insist, "We play for honor, not bragging rights. It has to do with honoring who you get the hit on."

Another player told me, "I compare playing The Game to my day job, science. We do a lot of data collection and data analysis; play our hunches. Our reward is not financial, but peer recognition. One selects some names to acknowledge the person. Other names are selected because earning you points is their last opportunity to do something

productive and honorable in their otherwise useless life. My most missed hit was Spiggy [Nixon's disgraced vice president, Spiro] Agnew; I was distressed at missing him."

Each Gamester pays $10 to Pontius, official coordinataor and editor, to keep score and report the hits. There are players in over 30 states (23 in New York), plus one each in Quito, Kuwait, England and Australia. You can become a Gamester only by being recommended by another Gamester. They're mostly baby boomers, attracted by a whimsical, informative style of reporting.

Forty-nine Gamesters "hit" Buddy Ebsen. Obituaries mentioned that after ten days of filming *The Wizard of Oz*, Ebsen fell ill because of the aluminum make-up on his skin, and was replaced as the Tin Man by Jack Haley. (A suspicious player wondered, "Did Jack Haley add something to the aluminum make-up at the *Wizard* set?") Conversely, there have been "solo's" on the unexpected demise of Princess Diana and JFK, Jr.

"A solo I am proud of," one Gamester told me, "is the hit on Christian Nelson, who invented the Klondike Bar."

"Yes, it's sick," another player admitted, "but c'mon, *it's just a game!* The Game is a light-hearted way of spitting in death's eye--your opportunity to pick a Generation-X rock star who OD's on heroin, a

geriatric blue-hair who finally kicks the bucket, a fascist totalitarian in the Mid-East who is assassinated. I' m not doing great this year because I invested too heavily in Hamas, but I' m still in the top ten. The IDF [Israel Defense Forces] is doing its job--I just guessed wrong. Last year I scored on Khattab, a Chechnian rebel leader who was killed by a letter he opened that was poisoned. Our first poison-pen-letter death."

But isn' t it somewhat ghoulish?

"Ghoulish?" a participant replied. "No more so than fantasy baseball. We can get up in the morning, and either pick up the newspaper or turn on the Internet to see if we scored, every day. It' s like baseball stats, you want to move up in the standings of the veterans. The reason we Gamesters play, I would say it' s about *style*. Style involves who you pick. Some concentrate on music, some on politics, some on sports."

As for social significance, one player explained that "The pastime has been going on for more than four hundred years, so I don' t think it' s reflective of any given time or society. Every Gamester comes with their own perspective. The Game is irreverent, even a bit shocking, and some take pleasure in that. It' s a poke to the ribs that lie beneath stuffed shirts, a tweak of bluenoses. The Game is a competition—challenging, engaging and energizing. The Game heightens awareness and helps us to

recognize our kinship with those whose deaths we note. The Game is a way of sharing and staying in touch with friends, whether near or far. It gives people a reason to call and correspond."

Pontius' s predecessor, Ghostwriter, had thanked many folks in his farewell message, including "Persephone, who enabled me to say, 'Yes,' when a friend here in Central New York said, 'Do you know a good adoption lawyer in Arkansas?' It was my greatest cameo role, my finest hour as a networker, and I couldn' t have done it without The Game and this wise, wonderful woman."

The Game' s listserv emails are titled "It' s a Hit!" They can be poignant, respectful, even sentimental: "July 4th—A score of swaying Gamesters were heard singing 'I Can' t Get Enough of Your Love, Babe' as each collected a five-note from velvety-voiced singer Barry White . . ."

Or they can sound like a warhorse race: "July 22nd—Mosul, Iraq. Qusay and Uday, the brutal and powerful sons of former Iraqi dictator Saddam Hussein, were ambushed by Special Forces and the 101st Airborne that resulted in a deadly four-hour firefight. Enjoying the best day of his career was Tomb Essence who had a 14-point Daily Double . . ."

But The Game giveth and the Game taketh away: "August 21st—British and American armed forces in Iraq announced today that

they had arrested Ali Hasan al-Majid, aka Chemical Ali. Back in April 2003, the British armed forces announced they had killed him. Tomb Essence celebrated then, but is crying like a baby now."

Animals have also been "scored," from Morris the Cat to Dolly the cloned sheep to Keiko the killer whale. Choices can get personal, though. A player told me, "I purposely Left off a good friend [former *New York Post* editor Jerry Nachman] who I knew was dying, and one of our game mates refused to list a friend's [famous] mother who knew she was dying. Sometimes we just don't want to 'cash in' on our friends' pain. How un-American of us."

Gamesters have scored on all the Kennedys as well as Lorraine Petersen, the model on the Sunmaid Raisins box. But, under the title "It's *Not* a Hit!" came this email: "August 9 th—The entire Game failed to list dancer and actor Gregory Hines, 57." In The Game's 2001 Hit List, under the subhead "Other Notable Deaths That No One Picked," included was "Ken Kesey, 11/1201, author, *One Flew Over the Cuckoo's Nest*."

I had a visceral reaction. This was not abstract.

"I never could decide if leaving Kesey off my list was the right thing to do," one Gamester told me. "The Merry Pranksters obviously inspired my *non de plume*, the Bury Pranksters."

Trashing the Right to Read

Before Kenneth Foster's death sentence was revoked at the last minute in August 2007, he had read a book, *Welcome to the Terrordome*, and he wrote a letter to the author, Dave Zirin:

I have never had the opportunity to view sports in this way. And as I went through these revelations I began to have epiphanies about the way sports have a similar existence in prison. The similarities shook me. Facing execution, the only thing that I began to get obsessive about was how to get heard and be free, and as the saying goes, you can't serve two gods.

Sports, as you know, becomes a way of life. You monitor it, you almost come to breathe it. Sports becomes a way of life in prison, because it becomes a way of survival. For men that don't have family or friends to help them financially, it becomes a way to occupy your time. That's another sad story in itself, but it's the root to many men's obsession with sports.

Zirin writes, "It didn't matter if he was on death row or Park Avenue, I felt smarter having read his words. But even more satisfying was the thought that thinking about sports took his mind--for a moment--away from his imminent death, the 11-year-old daughter he will never touch, and the words he will never write. I thought sending him my first book, *What's My Name, Fool?: Sports and Resistance in the U.S.,* would be a good follow-up."

But a form titled "Texas Dept. of Criminal Justice, Publication Review" was banned from Death Row because "It contains material that a reasonable person would construe as written solely for the purpose of communicating information designed to achieve the breakdown of prisons through offender disruption such as strikes or riots." Two pages were specifically mentioned.

Page 44 includes a quote from Jackie Robinson's autobiography referring to the blatant racism he suffered early in his rookie season: "I felt tortured and I tried to just play ball and ignore the insults but it was really getting to me. For one wild and rage-crazed moment I thought, 'To hell with Mr. Rickey's noble experiment. To hell with the image of the patient black freak I was supposed to create.' I could throw down my bat, stride over to that Phillies dugout, grab one of those white sons of bitches, and smash his teeth in with my despised black fist. Then I could walk away from it all."

And page 55 includes a passage about Jack Johnson's defeat of the "Great White Hope," Jim Jeffries: "Johnson was faster, stronger and smarter than Jeffries. He knocked Jeffries out with ease. After Johnson's victory, there were race riots around the country in Illinois, Missouri, New York, Ohio, Pennsylvania, Colorado, Texas and Washington, D.C. Most of

the riots consisted of white lynch mobs attacking blacks, and blacks fighting back. This reaction to a boxing match was one of the most widespread racial uprisings in the U.S. until the 1968 assassination of civil rights leader Dr. Martin Luther King Jr."

Zirin points out that "There was a time in Texas when it was illegal to teach slaves to read. The fear was that ideas could turn anger often directed inward into action against those with their boots on black necks. It is perhaps the most fitting possible tribute to Jackie Robinson and Jack Johnson that they still strike fear into the hearts of those wearing the boots."

In the Dallas County jail, one of the largest in the country, *all* publications are refused, including daily newspapers such as the *Dallas Morning News*. "They seem to have a rather callous disregard for the Constitution," said Paul Wright, publisher of Seattle-based *Prison Legal News*, with a circulation of 9,000. He filed a federal lawsuit challenging the ban on First Amendment grounds, and won. His lawyer, Scott Medlock, prisoner rights attorney with the Texas Civil Rights Project, points out that some jails have argued that prisoners can watch TV news in jail, so they don't need access to publications.

Prison Legal News is also preparing a lawsuit against the Utah Department of Corrections for a policy that bars all books except those that are shipped directly from Barnes & Noble. Generally, prisons require that books be sent directly from the publisher or a major distributor, for security reasons. Otherwise, a spokesperson for one jail explains, "There's a possibility something could be in one of the pages that we don't want. There could be little bits of drugs in the pages."

"We have not yet sued them." Wright told me, "since they only sporadically censor us and aren't letting us develop a good fact pattern."

A spokesperson for the Los Angeles County Sheriff's Department said that its jails allow inmates to receive books from booksellers after checking to see whether they can be fashioned into a weapon, promote violence or have sexually explicit content. Across the country, only paperbacks are accepted. Hardcovers are rejected because they provide "source material" for fashioning weapons. When the Supreme Court ruled that law libraries did not have to be provided to prisoners, jails in Montana not only removed the entire contents of the law library, but they also removed the typewriters.

Washington State has tried to keep *Prison Legal News* itself out of prisons. First, the Department of Corrections prohibited inmates from receiving nonprofits. *PLN* sued and won. Next, the state issued a rule that inmates couldn' t receive publications that were paid out of their trust accounts. *PLN* managed to get that rule overturned too. Then the prisons adopted a policy of not delivering subscription-renewal notices. _*PLN* took that to court and succeeded in getting the policy reversed. *PLN* has won similar lawsuits or settlements in Alabama, California, Michigan, Nevada and Oregon.

While serving five years in a California prison for growing medical marijuana, Todd McCormick contributed a couple of stories--about his experiences with psilocybin and ketamine--to my anthology, *Magic Mushrooms and Other Highs: From Toad Slime to Ecstasy,* and when it was published, I immediately sent him a copy. But the warden rejected it "because on pages 259-261, it describes the process of squeezing toads to obtain illicit substances which could be detrimental to the security, good order and discipline of the institution."

This was pure theater of cruelty. Federal correctional facilities do not have a toad problem, and outside accomplices have not been catapulting loads of toads over barbed wire fences to provide the fuel for a

prison riot. McCormick wrote to me, "Can you believe this shit! I wonder how much we pay the guy/girl who actually sits and reads every book that comes in for offending passages. How about you tear out pages 259-261 and re-send this book back with a copy of the rejection and a notation that the offending pages have been removed."

Which is exactly what I did. This time, though, my cover letter to the warden was ignored, and the book was returned, stamped "Unauthorized." I had called their bluff. Obviously, McCormick was being punished simply because he could be. I then corresponded with several prison correspondents around the country to find out what inmates had not been allowed to read. I wanted to see other examples of arbitrary and frivolous censorship by prison personnel. Here are some results of my informal survey:

* "The Texas Department of Corrections blocked Bo Lozoff's *Breaking Out of Jail*, a book about teaching meditation to prison inmates."

* "Disallowed: *Trainspotting* because of its 'glorification of drug use.' Tom Robbins' *Still Life With Woodpecker* because it has a chapter that 'contains information about bombmaking.' "

* "An inmate couldn't get nude pictures of his wife sent to him but he could get a subscription to *Playboy*. The rationale: A wife deserved more respect."

* "They kept out *The Anarchists Cookbook*. And no kiddie porn, no tales or photos suggesting sex with a guard, no photos showing frontal or rear nudity--not even a wife or friend."

* "The Utah prison system banned *Rolling Stone* as being an anarchist publication."

* "*A Revolution in Kindness* is banned from the Louisiana State Penitentiary at Angola as 'a threat to internal security.' It was intended for Herman Wallace, who contributed an essay about how he organized a chess tournament on his cellblock as a way of easing tensions and minimizing violence between inmates. Wallace is one of the Angola Three, Black Panthers who have been in solitary confinement for [more than three decades] trying to improve conditions in the 'bloodiest prison in America' in the early 1970s."

* "All hardback books forbidden, because the covers could be fashioned into weapons. Educational textbooks--a new rule precludes prisoners on Death Row [including this particular prisoner] or in lockdown from taking correspondence courses--and I've had a couple of books

returned to sender on the claim they appeared to be for a course. *MAPS* [Multidisciplinary Association for Psychedelic Studies]--their publication was sent back several times because maps are not allowed in here. *High Times* was repeatedly denied because it posed a danger to the safe, secure and orderly operation of the institution. 'Smut mags' like *Hustler* are reviewed monthly."

* "There's a whole new genre of men's magazines--*Maxim, Stuff, For Him*--which show it all except for nipples and beaver. Now the feds want to ban *Maxim* due to 'security' reasons. The 'rejected mail' slip they send you when some verboten material arrives has boxes to check (to specify offending matter), one of which says 'pubic hair.'"

* "Peace activist William Combs spent eight days in solitary confinement for receiving and sharing with other inmates what federal authorities consider disruptive, if not subversive, political literature. The offending 'propaganda' included commentary by such extremists as Bill Moyers and Ellen Goodman, and included an article published in *Reader's Digest*. The common thread was that they all questioned the wisdom of government policy."

The name of the game is control in the guise of security--a microcosm of the nation outside prison walls--the practice of power without compassion.

After *Magic Mushrooms and Other Highs* was rejected for the second time, I appealed to the Regional Director of the Bureau of Prisons (as instructed by the warden) for an independent review. I also wrote to the ACLU. I heard back from neither. Todd McCormick was released from prison in December 2003. Among so many other things to catch up on, he would finally be able to read what he had written. However, he was discharged to a halfway house, where all his books and magazines were confiscated as "paraphernalia."

Postscript: Prisoners at a jail in South Carolina are being denied any reading material other than the Bible. In May 2011, the ACLU asked a federal judge to block enforcement of that policy. A staff member at the prison told plaintiff *Prison Legal News*: "Our inmates are only allowed to receive soft back bibles in the mail directly from the publisher. They are not allowed to have magazines, newspapers, or any other type of books." There is no library there, and since 2008, all copies of *Prison Legal News* that were sent to prisoners have been "returned to sender."

In July 2017, the national Human Rights Defense Center organization has filed a federal lawsuit against the Kentucky Department of Corrections for violating free speech. It has unconstitutionally blocked the delivery of many books to state prisoners, including the *Prisoner Diabetes Handbook,* the *Merriam-Webster Dictionary of Law,* and the *Prisoners Self-Help Litigation Manual.*

Welcome to Camp Mogul

My irreverent friend, Khan Manka, Chairman & CEO of Manka Brothers Studios, had broken his ankle and was afraid he wouldn't be able to attend the 26th annual gathering of the nation's most powerful executives and their trophy wives in Sun Valley, Idaho. I really wanted to spy on this 2008 summer camp for billionaires, so I suggested that Manka get a wheelchair, then I could serve as his official wheelchair pusher, and he immediately went for the idea.

This by-now traditional five-day extravaganza for three hundred guests was hosted by Wall Street investment banker Herbert Allen, President and CEO of Allen & Company. There were moguls all over the campground, overflowing with the country's most influential leaders in

business, entertainment and media. I could feel myself developing a severe case of imposter syndrome.

Saturday was Talent Night, and it was absolutely hysterical. Part-time Sun Valley resident Tom Hanks served as the emcee. Warren Buffett was the opening act, performing a medley of Jimmy Buffett songs, all rendered out of tune. Amazon.com founder Jeff Bezos skillfully juggled five Kindles (wireless electronic books). Edgar Bronfman from Warner Music--dressed like the character Tevya in *Fiddler on the Roof*--sang with zest, "If I Were a Rich Man." Yahoo CEO Jerry Yang--who had previously turned down an offer from Microsoft to buy Yahoo--sang a duet with the ex-CEO of Microsoft, Bill Gates, harmonizing on a song from *Annie Get Your Gun*, "Anything You Can Do, I Can Do Better." Meg Whitman of EBay did a striptease, auctioning off each item of clothing, one at a time, and over 3 million dollars was raised for an unnamed charity. Oracle Corp. CEO Larry Ellison gave a hilarious lecture on "How to Destroy Evidence and Make False Statements."

There had been a lot of drinking in the evening, and it was obviously too much booze that loosened up Fox mogul Rupert Murdoch's tongue. He was shouting at the moon: "Who says there are twenty-seven million slaves around the world? And where the fuck can I get one? How would

anybody know it's twenty-seven million anyway? Do they have census takers or *what*? You tell me! I'll decide!"

Also, a screaming match broke out between Google co-founder Sergei Brin and Google CEO Eric Schmidt, over the infamous cover of the *New Yorker*, which depicted Barack and Michelle Obama as the new President and First Lady, a terrorist couple doing that fist-bump gesture in the Oval Office. Sergei thought it was a brilliant satirical illustration, but Eric thought it was racist and irresponsible.

Last year, the surprise guest was former British Prime Minister Tony Blair. This year, it was Steven Beschloss, the editor of a new magazine, scheduled to be launched in October 2008 and be delivered to 100,000 U.S. households with an average net worth of $25 million. There were piles of preview copies scattered about.

While Beschloss was holding court in an outdoor area, annoying mosquitoes kept buzzing around the crowd. Mark Zuckerberg, the founder of Facebook, yelled at him, "I guess we'll never hear *your* readers whining about a mental recession. And those of your subscribers who were in the sub-prime mortgage industry--these mosquitoes are *their* fault, because, along with all the home foreclosures they're responsible

for, the stagnant water in abandoned pools turns into new breeding grounds for mosquitoes."

Someone yelled out, "Where are you from, In-Your-Facebook?" Others drowned out Zuckerberg's apparently serious rant by singing the mogul version of a couple of good old-fashioned camp songs, "This Land Is *My* Land, This Land Is *My* Land" and "KumBuyYahoo." I couldn't help but notice that billionaire activist Carl Icahn snapped his fingers as if having an epiphany; a week later he ended up on Yahoo's board of directors.

Khan Manka explained that the bigwigs at these events have so-called "informal" meetings which always take place where a pair of individuals can have their discussions alone without any interruption--on the golf course, hiking along an isolated trail, fly-fishing at Silver Creek--but Manka had been privy to only one specific example that he could share.

"Back in 1995," he told me, "Disney honcho Michael Eisner met with Robert Iger, who was then the head of ABC. And exactly one month later, these two giant companies merged into one media megamonster. Coincidence? I don't think so. Their deal had been sealed when Eisner

and Iger exchanged friendship bracelets that they had worked on at Camp Mogul."

HIGHER THAN THOU

Checkmating With Pawns

It was a hot day at the chess tournament in Phoenix, Arizona—103 degrees, to be exact—and 14-year-old Nathaniel Dight was elated over his custom-made chess set. Those carved wooden pieces had been weighted precisely for the smooth moves he liked to make. Each one had been lacquered and, for this extreme heat, carefully protected by matte acrylic spray. But before the game could begin, young Nathaniel was ordered to take a urine test.

"I know why you're doing this," he snarled. "It's because I've won three tournaments in a row, isn't it?"

"No, son, that's just a coincidence. This is a random drug test."

"I don't do any drugs. I mean like when I get a headache from playing chess too long, I won't even take an aspirin."

"Look, here's a cup. I need you to go fill it, right now . . ."

All right, I confess, I made all that up, but consider the implications of something that I *haven't* made up:

America's drug czar, Barry McCaffrey, wrote in an article published in *Chess Life* magazine: "Research proves that mentoring youngsters and teaching them games like chess can build resilience in the face of illegal

drug use and other destructive temptations. Drug testing is as appropriate for chess players as for shot-putters, or any other competitors who use their heads as well as their hands."

Accompanying the television image of a couple of eggs sizzling in a frying pan, the phrase, "This is your brain on drugs" has always carried negative connotations, but apparently General McCaffrey has changed his mind about that. He now seems to believe that drugs can actually *improve* the way your brain functions.

There was an infamous chess player named Alexander Alekhine who held the world championship longer than anybody else. His games often had superb surprise endings, known in chess circles as "brilliancies." For instance, he would checkmate with a pawn move that no sane and sober mind could ever imagine. However, he was a notorious alcoholic, and McCaffrey is only referring to illegal drugs.

"Just when I thought I'd heard it all from McCaffrey," was the reaction of Allen St. Pierre, executive director of the NORML (National Organization for the Reform of Marijuana Laws) Foundation. "Drug testing for chess players? What's next from this overreaching drug czar? Drug testing for tiddlywinks players? How about bingo players?"

Moreover, McCaffrey's proposal smacks of subliminal racism. Social psychologist Walli Leff tells me, "I think most of the movement to involve young people in chess is directed toward the African-American community, and the assumption is, if the kids are black they're going to be drug users. I think white middle-class suburban parents would have a fit if their kids had to take drug tests for their extracurricular activities. Or am I out of it and am I missing a new, white middle-class suburban submissiveness?"

McCaffrey had been influenced by Chesschild, a group sponsored by the Office of National Drug Control Policy (ONDCP). Chesschild is a substance abuse prevention program conducted in libraries and schools, promoting a combination of drug-free lifestyles and chess.

"Policy recommendations like this one from ONDCP," said St. Pierre, "demonstrate a deep and disturbing pathology that goes well beyond opposing drug-law reform efforts."

Maybe the drug-law reformers should follow the example of gay-rights activists by having celebrities come out of the pot-smoking closet. Already, veteran stand-up comic George Carlin—in an interview by *The Daily Show's* Jon Stewart following Carlin's HBO special—admitted that

he smokes a joint to help him "fine-tune" his material. "One hit is all I need now and it's punch-up time."

At the Shadow Convention that took place while the Democrats were in Los Angeles, Bill Maher revealed to the audience, "I'm not just a pot reformer, I'm a user"—something which ABC forbids him to say on *Politically Incorrect*—then quickly added, "Just making a light remark there, federal authorities."

Actor and hemp activist Woody Harrelson has stated, "I do smoke." Willie Nelson confirmed in his autobiography that he smoked pot in the White House. And on KRLA, radio talk-show host Michael Jackson's program, Michelle Phillips, actress and former member of the Mamas and the Papas, said that she still enjoys smoking marijuana.

Just as Ellen DeGeneres appeared on the cover of *TIME* magazine saying, "Yep, I'm gay," there might come a day when a presidential candidate will appear on the cover of *Newsweek* saying, "Yep, I'm stoned." Isn't that what young pot-smokers need—good role models—so they won't be ashamed of their private pleasure seeking?

Meanwhile, drug czar McCaffrey would continue his crusade, not only against illegal substances, but perhaps also against certain food supplements, such as a popular herbal mixture with a reputation for aiding

memory and concentration. Who could ever have dreamed that chess players might get in trouble for using ginkgo biloba as a performance enhancer?

Tim Leary, Ram Dass, and Me

In 1964, I assigned Robert Anton Wilson to write a front-cover article in *The Realist,* which he titled "Timothy Leary and His Psychological H-Bomb." When that issue was published, Leary invited me to visit the Castalia Foundation, his borrowed estate in Millbrook, New York.

The name Castalia came from *The Bead Game* by Herman Hesse, and indeed, the game metaphor permeated our conversation. Leary talked about the way people are always trying to get you onto their game-boards. He discussed the biochemical process "imprinting" with the same passion that he claimed he didn't believe anything he was saying, but somehow I managed to believe him when he told me that I had an honest mind.

"I have to admit," I said, "that my ego can't help but respond to your observation."

"Listen," he assured me, "anybody who tells you he's transcended his ego . . ."

Leary and his research partner, Ram Dass (then Richard Alpert) were about to do a lecture series on the West Coast. At the University of California in Berkeley, there was an official announcement that the

distribution only of "informative" literature (as opposed to "persuasive" literature) would be permitted on campus, giving rise to the Free Speech Movement, with thousands of students protesting the ban in the face of police billy clubs.

Leary argued that such demonstrations played right onto the game boards of the administration and the police alike, and that the students could shake up the establishment much more if they would just stay in their rooms and change their nervous systems. But it wasn't really a case of either-or. You could protest *and* explore your 13-billion-cell mind simultaneously.

I became intrigued by the playful and subtle patterns of awareness that Leary and Alpert manifested. If their brains had been so damaged, as mythologized by mainstream media, how come their perceptions were so sharp? I began to research the LSD phenomenon, and in April 1965 I returned to Millbrook for my first acid experience. Tim Leary was supposed to be my guide, but he had gone off to India.

Dick Alpert was supposed to take his place, but he was too involved in getting ready to open at the Village Vanguard as a comedian-philosopher. I chatted with him for a while. He was soaking his body in a bathtub, preparing his psyche for the Vanguard gig. He had taken 300 acid

trips, but there I was, a first-timer, standing in the open doorway, reversing roles and comforting him in his anxiety about entering show business.

When I told my mother about taking LSD, she was quite concerned. She warned me, "It could lead to marijuana." And she was right. It did.

After Leary got arrested in Texas for possession of pot, the notoriety of his research in Millbrook spread. Law enforcement in nearby Poughkeepsie, led by Assistant District Attorney G. Gordon Liddy, raided the estate. In the summer of 1966, Leary and his associates ran a two-week seminar on consciousness expansion, culminating in a theatrical production of Hesse's *Steppenwolf* legend that weaved its way around the Millbrook grounds and buildings. Leary invited Liddy and members of the grand jury that indicted him, but none showed up.

Leary told me about prominent people whose lives had been changed by taking LSD: actor Cary Grant, director Otto Preminger, think-tanker Herman Kahn, Alcoholics Anonymous founder Bill Wilson, *TIME* magazine publishers Henry and Clare Boothe Luce. Of course, it wasn't so difficult to drop out when you had such a stimulating scene to drop into. On the day that he announced the formation of a new religion, the League for Spiritual Discovery (LSD), I signed up as their first heretic.

Alpert and I enjoyed what he called "upleveling" each other with honesty. On one occasion, we were at a party. I was particularly manic and he pointed it out, choosing an eggbeater as his analogy. I appreciated his reflection and calmed down.

On stage at the Village Theater, Alpert was sitting in the lotus position on a cushion, talking about his mother dying and how there seemed to be a conspiracy on the part of relatives and hospital personnel alike to deny her the realization of that possibility. He also talked about some fellow in a mental institution who thought he was Jesus Christ. Conversely, I teased him about discussing his mother openly but concealing the fact that the man who thought he was Christ was his brother--death obviously carrying more respectability than craziness. At his next performance, Alpert identified the man as his brother.

* * *

The essential difference between Tim Leary and G. Gordon Liddy was that Leary wanted people to use LSD as a vehicle for expanding consciousness, whereas Liddy wanted to put LSD on the steering wheel of columnist Jack Anderson's car, thereby making a political assassination look like an automobile accident. But who could have predicted that,

sixteen years after the original arrest, Leary would end up traveling around with Liddy in a series of debates?

I attended the debate in Berkeley in April 1982. Leary warned the audience that Liddy was a lawyer-- "trained in the adversary process, not to seek truth. I was trained as a scientist--looking for truth, delighted to be proved wrong." He confessed that "Liddy is the Moriarty to my Sherlock Holmes--the adversary I always wanted--he is the Darth Vader to my Mr. Spock."

"As long as it's not Doctor Spock," said Liddy. He argued that "the rights of the state transcend those of the individual." Not that he was without compassion. "I feel sorry," he admitted, "for anybody who uses drugs for aphrodisiacal purposes."

"Gordon doesn't know anything about drugs," countered Leary. "It's probably his only weakness." He looked directly at Liddy. "It's my duty to turn you on," he said, "and I'm gonna do it before these debates are over." Then he made a unique offer: "I'll eat a rat if you'll eat a hashish cookie."

Liddy turned down the offer--one can carry machismo only so far, and he had to draw the line somewhere--but he did provide appropriate grist for my own stand-up comedy mill. According to Liddy's book, he

actually ate a rat. He did it to overcome his fear of eating rats. Certainly a direct approach to the problem. None of that *gestalt* shit. Now, I'm not sure how he ate the rat, whether he just stuck it between a couple of slices of bread, or barbecued it first, or chopped the rat up and mixed it with vegetables in a stew.

But there were rumors that when Leary and Liddy were on tour, the Psychedelic Liberation Front found out their itinerary and began feeding hash brownies to rats and releasing them, one by one, in Liddy's room at the various motels he stayed at, while he was debating, in the hope that nature would sooner or later take its course, and one night Liddy would feel in the mood for a midnight snack, catch the rat that was left in the room, eat it and, by extension, the hash brownie the rat had eaten, and then Liddy would think he got stoned from eating the rat. This would, of course, be right on the borderline on the ethics of dosing.

* * *

Each tablet of Owsley White Lightning contained 300 micrograms of LSD. I had purchased a large enough supply from Alpert to finance his trip to India. The day before he left to meditate for six months, we sat in a restaurant discussing the concept of choiceless awareness while trying to decide what to order on the menu.

In India, he gave his guru three tablets, and apparently nothing happened. Alpert's postcard to me beckoned, "Come fuck the universe with me." Instead, I stayed tripping in America, where I kept my entire stash of acid in a bank vault deposit box.

Richard Alpert returned as Baba Ram Dass. Eventually, he dropped the Baba. He was now just plain Ram Dass. His father called him Rum Dum. His brother called him Rammed Ass. One afternoon he was visiting me, and I taped our conversation.

"In 1963," I said, "I predicted as a joke that Tiny Tim would get married on the Johnny Carson show, and in 1969 it happened. You and I talked about that, and you called it 'astral humor,' but I never knew exactly what you meant by that phrase."

"Well, it's like each plane of reality is in a sense a manifestation of a plane prior to it, and you can almost see it like layers, although to think of it in space is a fallacy because it's all the same space, but you could think of it that way. And so there are beings on upper planes who are instruments of the law. I talk about miracles a lot, but I don't live in the world of miracles, because they're not miracles to me. I'm just dealing with the humor of the miracle concept from within the plane where it seems

like a miracle, which is merely because of our very narrow concept of how the universe works."

Ram Dass knew of my involvement with conspiracy theory. "I'm just involved in a much greater conspiracy," he continued. "You can't grasp the size of the conspiracy I understand--but there's no conspirator--it's the wrong word. That's why I say it's just natural law. It is all perfect."

"Would you agree with the concept--what William Blake said, that humans were created 'for joy and woe'--the implication of which is that there will always be suffering?"

"I think that suffering is part of man's condition, and that's what the incarnation is about, and that's what the human plane is."

So I asked Ram Dass, "If you and I were to exchange philosophies--if I believed in reincarnation and you didn't--how do you think our behavior would change?" He paused for a moment. "Well," he said, "if you believed in reincarnation, you would never ask a question like that."

And then his low chuckle of amusement and surprise blossomed into an uproarious belly laugh of delight and triumph as he savored the implications of his own Zen answer. I would find myself playing that segment of the tape with his bell-shaped spasm of laughter over and over again, like a favorite piece of music.

Remembering Scott Kelman

Scott Kelman had seen me perform stand-up satire at Town Hall in New York in 1962, and again twenty years later at the L.A. Stage Company in Hollywood. He moved to Los Angeles and in 1984 launched an alternative theater in the grungy, old, industrial skid-row area of downtown. He named it the Wallenboyd (at the corner of Wall and Boyd) Theater and invited me to open there as soon as it was completed.

In fact, on the first night of my performances, the crew was still banging in the final nails. At the time, I was living in San Francisco, so Scott slept at his office and I stayed at his apartment in Venice Beach. A year later, I moved to an apartment on that same block. Scott became my producer and my close friend. We never had any need for a signed contract.

As my producer, he would occasionally give me suggestions and I would follow those that I felt worked for me. He'd say in his distinctive gravelly voice (he was addicted to cigarettes), "It doesn't matter if you fuck up—it's how you recover." That was theatrical advice, but it also applied to life.

And it was a two-way street. For Scott, whatever happened in life automatically became grist for his theatrical mill. He was an exemplary

explorer. Knowing I was an unbeliever, he once asked me, "What do atheists say during sex when they come?"

"Oh, *no*-God!" I responded, interspersing those words with moans and groans. "Oh, *no*-God! Oh, *no*-God! Oh, *no*-God!" He suggested that I expand that concept into a stage piece, and it evolved into a ten-minute meditation on the relationship between religion and orgasms.

Scott conducted theatrical workshops, and one of his students was John Densmore, the former drummer for The Doors. "I stumbled into the downtown art scene," Densmore told me, "after a big peak in rock' n' roll. It felt as creative as the ' 60s. I now get off on the *process*, and it doesn' t matter if it' s fifty people at the Wallenboyd or twenty thousand at Madison Square Garden, it' s the work that rings my bell."

Scott also produced Peter Bergman, of the Firesign Theatre. Scott thought that *Peter, Paul and Harry* would be a great title for an evening of political satire at the Museum of Contemporary Art. He asked the curator if she knew of an appropriate performer named Harry. She suggested Harry Shearer. Scott asked me about him. "He' s brilliant," I said, "let' s do it." And so he produced a completely sold-out series that was extended for two weekends.

But if Harry had been named after his *other* grandfather, there wouldn't have been a *Peter, Paul and Harry*. Each of us prepared to perform in our own particular way. Peter stared at himself in the mirror and made strange sounds to exercise his vocal cords. Harry sat in a separate room where his makeup woman, who had flown in from Iowa, transformed him into Derek Smalls from the mockumentary *Spinal Tap.*

And I was off hiding behind some boxes, toking away on a joint of the marijuana that served as my creative fuel. Scott was sure that I performed better when I wasn't high, and he was under the impression I was straight when he told me one night, "That was the best show you've ever done." I confessed that I had smoked a giant doobie before I went onstage. The irony was that Scott sold pot to help pay the rent, and that was exactly the stash that got me stoned that night.

The 20th Anniversary of the Summer of Love

I never went to any of my high school or college reunions, but I couldn't resist attending the twentieth anniversary of the Summer of Love in San Francisco. At noon on the summer solstice of 1987, young and middle-aged hippies--gray hair and potbellies, but not having erased a certain gleam in their eyes--were marching in an All Beings parade down Haight Street. Costumes ranged from a giant snail to Zippy the Pinhead.

One fellow still in civilian clothes explained, "I was supposed to be Tarzan, but I had to wash the dishes."

Local countercultural fixtures were all there: The Mime Troupe, Rosie Radiator and her fleet of tap dancers, the Automatic Human Juke Box, and a panhandler asking, "Can you spare a hundred dollars?" The buses now had posters that suggested *Shop the Haight*.

The charm of that entrepreneurial urge was not to be confused with the mission of the Haight-Ashbury Preservation Society, whose targets were symbolized by a walking Big Mac cheeseburger, a prisoner of Thrifty's in chain-store chains, mock pallbearers carrying a casket to mourn the wished-for death of Round Table Pizza, a sign warning *Don't Mall the Haight*! and somebody in a Merlin the Magician outfit with a

placard, *You don't need magic to fight the franchising*. A lone, sad-faced clown bore a banner with a white dove in a red heart.

In Golden Gate Park, an emcee asked the crowd a series of rhetorical questions to rev them up: "How many people were here in the sixties? . . . How many are here now? . . . How many don't know? . . . How many don't care?" A musician announced, "We were told not to have amplifiers, but we decided to break the law today." Hog Farmer Sharon Share-alike offered her roll of hard candy to novelist Herb Gold, which immediately aroused his fear of dosing. He asked, "These really are Life Savers, right?"

The Summer of Love reunion continued at the I-Beam, a disco on Haight Street. On stage, I compared the decades:

> In the sixties, marijuana was ten dollars an ounce. In the eighties, it's three hundred. In the sixties, teenagers used to hide their pot smoking from their parents. In the eighties, parents have to hide it from their kids. In the sixties, the favorite chemical drug was LSD. In the eighties, it's Ecstasy. In the sixties, Ken Kesey wasn't allowed to donate blood because he had ingested acid. In the eighties, there are those who are afraid to get a blood transfusion because of AIDS. In the sixties, Lenny Bruce got arrested for saying "cocksucker" on stage. In the eighties, Meryl Streep got an Academy Award for saying it in *Sophie's Choice*. Now, almost the entire audience at a Grateful Dead concert is younger than the number of years the band has been together--but these kids have less deconditioning to go through than we did. They have less innocence to lose.
>
> When a group of students and other protesters, including Abbie Hoffman and Amy Carter (the president's daughter), won their case against CIA recruiting on campus by using a "necessity defense," attorney Leonard Weinglass told me that the turning point for the

> jury was the testimony of Ralph McGehee, who revealed how he had been recruited right off the football field by the CIA, only to become a star player in their assassination-squad program. Members of the jury would not have voted that way in the sixties because they weren't prepared to believe such testimony as they are in the eighties.
>
> In the sixties, we knew that the CIA was smuggling heroin from Southeast Asia. And in the eighties we know that they're smuggling cocaine from Central America. The same planes that fly weapons for the *contras* to airports in Panama, Honduras and Costa Rica come back to Florida, Louisiana and Arkansas with their cargoes filled to the brim with cocaine, even though the administration is carrying on its anti-drug campaign. The pilots only have to be careful to evade the radar screen. So while Nancy Reagan is saying, "Just say no," the CIA is saying, "Just fly low."

Meanwhile, the quality of co-option had not been strained. The slogan "Today is the first day of the rest of your life" was used in a TV commercial for Total breakfast cereal. Tampax promoted its tampon as "Something over thirty you can trust." Beatles songs were used to sell cars, or, if you preferred to walk, they also sold sneakers. *Time* magazine was being peddled by the Byrds' version of Pete Seeger's song, "Turn, Turn, Turn" --based on Ecclesiastes—t here's a *time* for this and a *time* for that, get it?

The Youngbloods once sent a copy of their song "Get Together" to every member of Congress and the Senate, with a suggestion that it be established as the new national anthem, but who could ever have guessed

that it was really destined to become a jingle in a jeans commercial? Or that a Jefferson Airplane song would be used in a bank commercial? Or that Timothy Leary would model a Gap shirt for a full-page ad in *Interview,* and Ram Dass would peddle a rejuvenating skin cream at a Saks Fifth Avenue counter? *People* magazine was selling the twentieth anniversary of the Summer of Love with a feature story set off by a double-paged cover with psychedelic artist Peter Max's signature on both pages.

In red spray paint, on a brick wall just off Haight Street, standing out among the graffiti like John Hancock's signature on the Declaration of Independence, this message summed it all up: *Love Is Revenue.*

POLITICS

The Last Election

The Republicans' party line that Barack Obama was "palling around with terrorists" didn't work, although some people believed it because then they wouldn't need a racist reason not to vote for Obama. Next, the campaign acted as though his advocacy of age-appropriate sex education for kindergarteners meant putting condoms on cucumbers. That didn't work, either. Then John McCain tried calling him a "socialist." Also didn't work. Ironically, Socialist Party candidate Norman Thomas ran for president six times, and never won, but every one of his platform planks were eventually adopted by Democrats and Republican administrations alike. They just didn't *call* it socialism.

In January 2009, Christian broadcaster Pat Robertson stated that God told him America is headed for veritable socialism as well as an economic rebound under President-elect Obama. "What the Lord was saying," he claimed, "the people are willing to accept socialism to alleviate their pain. Cast off all the gloom and the doom because things are getting ready to turn around. I say with humility, I hope I've heard the Lord. I spend time praying and asking him for wisdom, and if there's a mistake, it's not his fault, it's mine." Humility in action.

In any case, one of the factors in Obama's win was indeed the confidence-destroying financial crisis, and now he faces a food chain of euphemisms. Hey, is this like the Great Depression? Nah, it's not a depression, it's only a recession. Wait, it's not a recession, it's just an economic downturn. No, it's not an economic downturn, it's a correction. Oops, it's not a correction, it's an adjustment. Hurry, get me a chiropractor. Similarly, there's a food-chain of solutions to the problem. From the Troubled Asset Relief Program to the Bailout Bill to the Rescue Package to the Emergency Economic Stability Act to Alan Greenspan confessing "My bad" to Free Botox for Everybody.

Perhaps the most bizarre byproduct of the campaign began with an anonymous ad on Craigslist, headlined: "Need Sarah Palin Lookalike ASAP for Adult Film." The pay would be $3,000 and, it was duly noted, "No anal required." This porn flick, it turned out, would be shot by Hustler Video, and no, Tina Fey did not apply for the job. The climactic scene was a threesome with Sarah Palin, Condoleezza Rice and Hillary Clinton.

Hillary was played by veteran porn star and sex educator Nina Hartley, who told me that "The big hullabaloo over the movie is being generated by feminists from both the pro- and anti-porn sides. They're up

in arms that 'women are being non-consensually satirized' by Big Evil Porn, and The Big Bad Larry Flynt. The usual nonsense from the usual suspects. Even some pro-porn feminists are upset at Palin being 'targeted' by porn. They conveniently overlook the fact that most porn satirizes white men in power: politicians, police, professors. Most recent case in point, *The Elliot Splizter Story* . . ."

Who's Nailin' Paylin was ready for release before the election, as was an issue of the horror comic book *Tales From the Crypt*, which featured on the cover a painting of Sarah Palin swinging her hockey stick to disperse the Vault-Keeper and other ghoulish characters as she sneeringly asks, "Didn't we get rid of you guys in the '50s?" --a reference to the censorship problems faced decades ago by EC Comics, the original publisher of *Tales From the Crypt*, and concomitantly a criticism of Palin for her "rhetorical question" about removing objectionable books from library shelves.

However, another publisher was producing a comic-book biography of Palin that wouldn't be released until February 2009, so two endings were prepared. But an edition of *South Park*--broadcast the day after the election--took a risk with only one ending, which lampooned Obama's victory. Co-creator Trey Parker explained, "We're just going

to make the Obama version, and if McCain somehow wins, we're basically just totally screwed." Likewise, Garry Trudeau gambled that Obama would win, and his syndicated *Doonesbury* strip--published the day after the election--depicted three soldiers in Iraq watching the returns on TV as a reporter is saying, "And it's official--Barack Obama has won."

Some editors were undecided about whether to publish it. Trudeau encouraged them to choose hope over fear. "If I'm wrong," he told the *Los Angeles Times*, "it'll be my face that'll be covered with eggs, not theirs." *Times* editors had decided, in the interest of accuracy, to wait for the election results, and if Obama won, they would publish the strip on Thursday, but then they must have realized it was just a comic strip, not investigative journalism, and they published it on Wednesday after all.

Trudeau thought that newspapers should run the strip because "polling data gives McCain a 3.7% chance of victory." Indeed, a week after Obama's win, McCain himself admitted to Jay Leno, "I can read the polls--they tried to keep 'em from me." There were dozens of polls, from ABC to Zogby, and, psychographic sophistication aside, they didn't always exactly agree. For example, in Nevada during the last week of October, one poll put Obama's lead at 12%, another at 7%, another at 5% and two others at 4%, which meant that, given the margin of sampling

error, McCain could conceivably have been slightly ahead. This, then, was the last presidential election. In the future, you'll only need to vote for the pollster that you trust the most.

During the 1968 Democratic convention in Chicago, I was among 15,000 protesters who had gathered in Grant Park for a rally when the police, triggered by the actions of one of their own provocateurs, attacked the demonstrators and sadistically beat as many as they could reach. It seemed impossible that we could ever work within the system. But now, forty years later, there were 200,000 celebrants who had gathered in that same park, giddy with the excitement of Obama's victory. They had worked within the system.

During the past four decades, there has been a linear progression from Jimi Hendrix playing "The Star-Spangled Banner" at Woodstock to Aretha Franklin singing "My Country, 'tis of Thee" at the inauguration. Is it possible that this event signified the early tremors of a nonviolent revolution? As the late singer/songwriter Harry Chapin once said to me backstage at a benefit: "If you don't act like there's hope, there *is* no hope." And remember, placebos work. My hope is I don't get disappointed. [But I did.]

Meanwhile, the memorabilia business flourishes as millions of voters seek a variety of tangible items to remind them of the part they played in history simply by voting. Mouse pads, baby bibs, aprons, dog jerseys, bobble-heads, niche buttons ("Ventriloquists for Obama"), T-shirts ("Now I Don't Have to Move to Canada") and, as reported by NPR, Obama condoms. Somebody bid $400 on eBay for the November 5th issue of the *New York Times*. *USA Today* printed 500,000 extra copies; the *Washington Post* printed 350,000 extras. The only thing I saved was a full-page ad by the 99 Cents Only stores, which included a "Joe the Plumber Special" plunger. There was no limit on how many I could buy.

A Letter to Barack Obama

October 10, 2010

Dear President Obama,

It seems that the theme emanating from the White House is "Eat, Pray, Be Disappointed." And yet, whenever I do feel disappointed, I always realize that the alternative was John McCain, with Sarah Palin just one Halloween "Boo!" away from the presidency, and then I always feel a sense of relief.

Actually, you've kept one big campaign promise--to send more troops to Afghanistan--so I guess we can't fault you for that. In fact, according to Bob Woodward in *Obama's Wars*, all you want to do now is get *out* of Afghanistan. Well, why don't you just do what Osama bin Laden did; cross over to Pakistan. Since we bribe Pakistan to be our ally, you'd think they would never consider harboring bin Laden, though they reek with empathy when our outsourced drones drop those bombs.

Also, during the campaign, you said you believe that the legality of same-sex marriage should be decided by the states, but that you personally think marriage should be between a man and a woman. Which is exactly the position that eventually led to the revocation of Carrie

Prejean's Miss USA crown. And another thing. You promised to end the raids on medical marijuana dispensaries, but they haven't stopped.

[In 2009, Attorney General Eric Holder issued a memo ordering an end to federal raids of medical marijuana dispensaries. In March 2011, there were 28 such raids in a duration of 24 hours.]

Here's how I understand Washington. America's puritanical political process serves as a buffer between the status quo and the force of evolution. For instance, in order to get Republican votes for the children's healthcare bill, Democrats agreed to fund $28 million to *their* abstinence-only program.

And, during your own campaign, you admitted, in the context of health care reform, that the multinational insurance conglomeration is so firmly entrenched that you would be unable to dispense with it. So there would have to be compromises. Now, what with the compromises made to help passage of Prop. 19, amnesty becomes the single-payer system of marijuana reform, and growing your own pot becomes the public option. Meanwhile, as long as any government can arbitrarily decide which drugs are legal and which drugs are illegal, then anyone serving time for a nonviolent drug offense is a political prisoner.

In his new book, Bob Woodward writes about Colin Powell's status as an adviser to you. Referring to his previous book, *Plan of Attack*, the *New York Times* then reported that "Secretary of State Colin Powell disputed Woodward's account....He said that he had an excellent relationship with Vice President Dick Cheney, and that he did not recall referring to officials at the Pentagon loyal to Cheney as the 'Gestapo office.'" Who among us would be unable to recall uttering such an epithet? Powell later apologized for it. He has also changed his mind about gays in the military. In my capacity as a stand-up satirist, I used to conduct an imaginary dialogue with Powell.

"General Powell, you're the first African-American to be head of the Joint Chiefs of Staff, and you come from the tradition of a military family. So you know that blacks were once segregated in the Army because the other soldiers might feel uncomfortable if blacks slept in the same barracks. And now that's what they say about gays, that other soldiers might feel uncomfortable about *gays* sleeping in the same barracks."

"Well, you have to understand, we never *told* anybody we were black."

And, Mr. President, that was the forerunner of the same "Don't ask, don't tell" policy that you promised to rescind, only you haven't been acting like a Commander-in-Chief. All you have to do is sign such a directive. Those who serve in the military are trained to follow orders. If they can follow orders to kill fellow humans, they can certainly follow orders to treat openly gay service people with total equality.

Not only is the current guideline counterproductive, but also this display of trickle-down immorality must, on some level of consciousness, serve as a contributing factor to enabling the anti-gay bullying and torturing of innocent victims. I know, you don't want to take a chance that retracting the policy would interfere with your re-election. You've made the point that you don't want Mitt Romney to win in 2012 and turn around all the good things you've accomplished.

Incidentally, Romney had wanted to overturn Roe *vs.* Wade, yet, in 1994, when he was running for the Senate, he came out in *favor* of choice for women. However, freelance journalist Suzan Mazur revealed that he admitted to Mormon feminist Judith Dushku that "the Brethren" in Salt Lake City *told* him he could take a pro-choice position, and that in fact he probably *had* to in order to win in a liberal state like Massachusetts. Pandering trumps religious belief.

Meantime, since gays and lesbians have waited so long for basic fairness, they might as well just wait for the next election. If you win, then would you kindly do immediately what you believe is right, constitutionally and in your heart, and end this injustice? The ultimate irony is that gays in the military are fighting, being maimed and dying unnecessarily, supposedly to protect the freedom their own country is denying them.

Sincerely,
Paul Krassner

Postscript:

I sent a copy of the letter to some folks that day. Among the responses, I received a message from a mother: "I am trying to explain this to my twelve-year-old son, who wants to know why, if men and women don't share barracks in the military, why gay men and hetero men should share barracks, but then follows with 'They should all sleep in the same place.'"

And that evening I received this email from a seasoned journalist: "I know it's late, but I cannot wait to ask if this letter is a spoof, or you've actually sent it to Obama. If it's a spoof and you've not sent it to him, would you like to? I've got his fax number and he's got a great sense of humor. May I have your permission to send this to him?"

"Absolutely."

Two days later, to the dismay of Obama--who told a town hall meeting that he was restricted because the "Don't ask, don't tell" policy was written into law, adding, "This is not a situation where I can, by the stroke of a pen, end this policy" --he wanted Congress to repeal it after the November midterm election, but Federal Judge Virginia Phillips upset that timetable by issuing an immediate and permanent ban on what she considered to be unconstitutional. This ruling was not a spoof, though it was treated as one by an appeals court that set aside her injunction. In December 2010, Congress repealed the 17-year-old law.

Nor was it a spoof when Attorney General Holder—having been pressured by nine former DEA chiefs, plus the president of Mexico--warned that if Prop. 19 was passed, making California the first state to legalize pot, the federal government would not look the other way, as it has done with medical marijuana. Holder (who wouldn't prosecute the Bush administration for promulgating torture) explained:

"Let me state clearly that the Department of Justice strongly opposes Proposition 19. If passed, this legislation will greatly complicate federal drug enforcement efforts to the detriment of our citizens. We will vigorously enforce the [law] against those individuals and organizations

that possess, manufacture or distribute marijuana for recreational use, even if such activities are permitted under state law."

In a truly free society, the distinction of whether marijuana is used for medical or recreational purposes would be as irrelevant an excuse for discrimination as whether the sexual preference of gays and lesbians is innate or a matter of choice.

And so it came to pass that Barack Obama was re-elected. His opponent, Romney, fell to his knees and pleaded, "Oh, dear Lord, you promised that I would win. Why hast thou forsaken me?" And the voice of God boomed out, *"HEY, MITT, LISTEN--I WAS JUST FUCKIN' WITH YA . . ."*

Unsafe at Safeway

It was Steve Allen, and later Lenny Bruce, who said that "Comedy is tragedy plus time." But everything is accelerating. Even the rate of acceleration is accelerating. The time between tragedy and comedy gets shorter and shorter. The more horrible the news is, the more victims there are to involuntarily serve as setups for punchlines.

Reality has long been nipping at the heels of comedy, and it finally caught up. Example: On the same day that people were being burned alive in the fire at the Branch Davidian headquarters in Waco, Texas, Jay Leno did a joke in his *Tonight Show* monologue about there being two kinds of cult members there-- "regular and crispy."

Of course, events like the recent madman massacre outside a Safeway supermarket can be challenging. How could made-up humor possibly top the actual absurdity of mass murderer Jared Loughner asking his MySpace friends not to be mad at him. After all, he was merely planning to indiscriminately kill as many innocent human beings as he could, with democracy itself as collateral damage.

The night before Loughner committed his senseless slaughter, he had taken photos of himself posing with his gun while wearing a bright

red G-string and displaying his naked ass. Satirist Harry Shearer observed that "The nightmare in Tucson is the inevitable result of a society where a mentally confused young man can purchase a red G-string anywhere at any time, and pose with it as he sees fit. Can't we all agree now to lower the temperature on underwear?"

Speaking of lowering the temperature, in the *Pittsburgh Post-Gazette*, editorial cartoonist Rob Rogers depicted the U.S. Civil Discourse Gun Shop where a customer is asking the clerk: "Do you have anything versatile enough to go from a campaign breakfast to a protest march to a Town Hall meeting?" And in the *Orlando Sentinal*, Dana Summers depicted another gun store featuring semi-automatic 31-clip weapons, where the clerk is explaining to a customer: "Say you have thirty-one burglars break into your house."

On the Monday following the tragic weekend, Jon Stewart was unable to find anything funny about it. Nor was Stephen Colbert, although he did present a montage of news clips with various explanations of Loughner's behavior, and the final one, from Fox News— "He is also being described as a left-wing political pothead" —managed to evoke laughter from the audience. And Rush Limbaugh called him a "marijuana junkie."

In October 2008, Loughner told an old friend, Bryce Tierney, that he wasn't going to smoke marijuana any more. Tierney never saw him smoke pot again, and was surprised at media reports that Loughner was rejected by the Army in 2009 for failing a drug test: "He was clean...I saw him after that continuously. He would not do it...After he quit, he was just off the wall." But Loughner did *not* fail a drug test that day at the processing station. Rather, he admitted on an application form that he had smoked marijuana "hundreds of times." He didn't know that the military has an official maximum of times you can admit to smoking pot.

A journalist I know acknowledges that he tried to join the Air Force at the San Diego recruitment office, but, "When the subject of drugs came up, I figured, okay, I have long hair, I look maybe homeless, they're going to *know* I'm lying if I say I've always been straight. I'll say I've smoked pot seven or eight times--something ridiculously, embarrassingly low. Whatever it was, it was too high. The recruiter said. 'You can't have smoked more than *five* times. Go away, kid. Maybe the Marines will take you.' Two weeks later I was at the Sacramento recruitment office and I had the 'magic number.' I joined the Air Force. One of the stupider things I've done."

Indeed, Chris Hedges wrote on *TruthDig*: "Power does not rest with

the electorate. It does not reside with either of the two major political parties. It is not represented by the press. It is not arbitrated by a judiciary that protects us from predators. Power rests with corporations. And corporations gain very lucrative profits from war, even wars we have no chance of winning. All polite appeals to the formal systems of power will not end the wars in Iraq and Afghanistan. We must physically obstruct the war machine or accept a role as its accomplice."

When it comes to bloodbaths, the only difference between such invisible corporations and Jared Loughner is that he did it face-to-face.

Obviously, Loughner is crazy, but not legally insane, because he knew right from wrong, as indicated by his expectation of life in prison or execution for his unspeakable crime. True, John Hinckley was crazy when he tried to assassinate Ronald Reagan—his motivation was to impress actress Jodie Foster so she would go out bowling with him--yet he was sentenced to serve *his* time in a mental hospital, including occasional outings with his parents, which resulted in public outrage and a weakening of the insanity defense.

Ironically, Hinckley came out for gun control, and Reagan came out against it.

The Yippies and the Occupiers

As a co-founder of the Yippies (Youth International Party)—known for demonstrating against the Vietnam War at the 1968 Democratic convention in Chicago--I find myself comparing and contrasting the Yippies and the Occupy Wall Street protesters.

We had to perform stunts to get media coverage of our cause, so a group of us went to the New York Stock Exchange, upstairs to the balcony, and threw $200 worth of singles onto the floor below, watching the gang of manic brokers suddenly morph from yelling "Pork Bellies" into playing "Diving for Dollars." Then we held a press conference outside, explaining the connection between the capitalist system and the war.

Now, a particular placard, "Wall Street Is War Street," gives me a sense of continuity. Other anonymous Occupier spokespersons carried posters proclaiming: "God Forbid We Have Sex & Smoke Pot. They Want Us to Grab Guns & Go to War!" "I am an immigrant. I came here to take your job. But you don't have one." "$96,000 for a BA in Hispanic transgender gay & lesbian studies and I can't find work!" And a woman in a wheelchair: "Stand Up For *Your* Rights!"

By the sheer power of numbers without the necessity of stunts, the Occupiers have broadened public awareness about the economic injustice perpetuated by corporations without compassion conspiring with government corruption that has resulted in immeasurable suffering. The Yippies were a myth that became a reality. The Occupiers are a reality that became a myth. The spirit of nonviolent revolution is what connects them.

NPR waited until eleven days of Occupy Wall Street had passed before reporting its existence. The executive news editor explained that the Occupiers "did not involve large numbers of people" (actually, there were already several hundred), no "prominent people" showed up (thus ignoring Michael Moore and Susan Sarandon), the lack of "a great disruption" (the police pepper-spraying protesters trapped in a cage of orange netting finally met that need), "or an especially clear objective" (oh, right, like all those flip-floppy pandering politicians whose clear objective is to get elected).

The Occupiers appear to be a leaderless community—most likely, you can't name a single one; not yet, anyway—whereas Abbie Hoffman, Jerry Rubin and I served as spokespeople for the Yippies. We had media contacts and knew how to speak in sound bytes. If we gave good quote,

they gave free publicity for upcoming demonstrations. It was mutual manipulation.

Sample: A reporter asked me about the 1968 counter-convention we were planning, "Will you be staying in tents?" I replied, "Some of us will be intense. Others will be frivolous."

During an interview with Abbie and me for the CBS Evening News, taped at his apartment, Abbie paraphrased Che Guevara and said, "I'm prepared to win or die." However, that never got on the air. When the reporter asked me, "What do the Yippies actually plan to do in Chicago?" I smiled at her and said, "You think I'm gonna tell *you?*" That portion of my answer was used to end Walter Cronkite's segment on the Yippies, but my follow-up sentence-- "The first thing we're gonna do is put truth serum in the reporters' drinks" --was omitted. They had beaten me at my own game.

The Yippies were inspired by the Buddhist monk in Vietnam who set himself on fire in order to call attention to the war. The photo of that incident traveled around the globe, and I wore a lapel button which featured that flaming image. Similarly, in 2010, a street vendor in Tunisia refused to pay a police bribe, then immolated himself, which inspired a

revolution there, and next in Egypt, spreading into Arab Spring, which ultimately inspired American Autumn in 2011.

Inspired by the Yippies attempt to levitate the Pentagon, pie-thrower Aron Kay wanted to get fellow Occupiers to levitate Wall Street. No interest. Likewise, inspired by the Yippies nomination of an actual pig named Pigasus for president, Michael Dare tried unsuccessfully to persuade fellow protesters at Occupy Seattle to carry out his notion that, "If corporations are people, let's run one for president." I offered myself as Secretary of Greed.

The evolution of technology has changed the way protests are organized and carried out. The Yippies had to use messy mimeograph machines to print out flyers that had to be stuffed into envelopes, addressed, stamped and mailed. The Internet generally—and social media such as Facebook and Twitter—have enabled Occupiers to inexpensively reach countless people immediately.

When the Yippies were being tear-gassed, and beaten sadistically and indiscriminately, we chanted, "The whole world is watching!" But now, when a bloodbath was expected to happen if the New York police forced the Occupiers out of the park—and then that didn't

happen—Michael Moore asked a cop, "Why don't you think the eviction happened?" The reply: "Because the mayor's afraid of YouTube."

(One month later, Mayor Bloomberg apparently lost that fear; by his order, the eviction happened at 1 a.m. The next afternoon, a protester, before being allowed back in, was overheard remarking, "The cops have occupied Zuccotti Park. We're just trying to figure out what their demands are.")

Not only what occurred in Chicago in 1968 was officially labeled "a police riot" by a government-sponsored investigation, but also an undercover police provocateur—who was disguised as a local biker and acted as Jerry Rubin's bodyguard—would ultimately state that he participated in pulling down the American flag in Grant Park, destroying it, then running up the black flag of the Viet Cong in its place.

"I joined in the chants and taunts against the police," he said, "and provoked them to hitting me with their clubs. They didn't know who I was, but they did know that I had called them names and struck them with one or more weapons."

Now, as the Occupy model has spread around the country, police brutality has increased, and it's not surprising that there have been accusations of provocateurs sabotaging the nonviolent principle, not to

mention an assistant editor at a conservative magazine who infiltrated a group of protesters in Washington, D.C., later claiming that his purpose was "to mock and undermine them in the pages of the *American Spectator,*" and that he helped incite a riot at the National Air and Space Museum, getting pepper-sprayed in the process.

Moreover, a document from the Houston FBI revealed their plan "to engage in sniper attacks" and "kill the leadership" of the Occupy activists "if deemed necessary."

The Yippies were essentially countercultural, an amalgam of radicalized stoned hippies and straight political activists. And, although the Occupiers are essentially mainstream, their demonization by right-wing media pundits has been providing a repeat performance of neutralizing a progressive cause.

Bill O' Reilly called the Occupiers "drug-trafficking crackheads" and "violent America-hating anarchists." Sean Hannity said they "sound like skinhead Nazi psychos." Ann Coulter referred to them as mobs of "teenage runaways" and "tattooed, body–pierced, sunken-chested 19-year-olds getting in fights with the police for fun." Glenn Beck warned that they "will come for you and drag you into the streets and kill you."

Andrew Breitbart declared that Occupy Wall Street is "a group of public masturbating violent freaks."

And Rush Limbaugh labeled them "dumbed down" and "propagandized" and asked a rhetorical question reeking with layers of irony: "Whatever happened to the '60s--*Question Authority*?" At this point, Limbaugh is like a castrated canine that is still busy humping the living-room sofa by force of habit.

PORN AGAIN

Remembering Pubic Hair

Okay, call me old-fashioned, but I still like pubic hair. Internet porn sites now present several choices--completely shaved, vertical landing strips that look like exclamation points, heart shaped, the Charlie Chaplin with just a little patch above the clitoris, and a tiny triangle that serves as an arrow *pointing* to the clit--yet, for a full bush, one would have to search the Web for "hairy" sites that are considered as "specialty," "kinky" or "fetish."

Retired porn stars have commented on this phenomenon. Gina Rome, retired after six years, shaved every day. "It was part of getting ready for work." When she switched from acting to film editing, she stopped shaving and let her pubic hair grow out. "Shaving was work. I don't have to do it any more, so I don't." And Kelly Nichols says, "I was a *Penthouse* model in the early 1980s, and I posed with a full bush. No one in adult entertainment shaved back then. Now everybody does."

Although Martha Stewart is back on TV, you can be sure that she'll never give any suggestions on what to do about those big red razor bumps that result from shaving your vagina, so here's a helpful hint I'd

like to pass along--they can be largely eliminated with, of all things, Visine eye drops. But pubic hair is practical; serves as a cushion against friction.

The porn industry has played an important part in shaping pubic styles. Jordan Stein writes in an article titled *Has Porn Gone Mainstream?:* "Consider the near icon status the female porn star has achieved. She is so mainstream that even good girls are imitating her various styles of undress, disappearing hair and all. Porn chic? You bet."

However, Julia Baird writes in *Celebrity Porn*: "The idea that the fashion industry can strip, then exhibit women in the name of 'porn chic,' is a bit silly, frankly. But 'flesh is the new fabric' could be the new catch-cry. Americans call their bush George W. It's fashionable--the curious fact is that it is fueled by the porn aesthetic that celebrities love to love."

Among Hollywood actresses, Gwyneth Paltrow and Kirstie Alley have both admitted favoring Brazilian wax jobs, where most of their pubic hair is removed, leaving a small tuft that remains hidden under a thong bikini. Sara Jessica Parker's character, Carrie Bradshaw, had her pubic hair removed during the third season of *Sex In the City*. Presumably, it's now in the Smithsonian museum along with Archie Bunker's easy chair and the Fonz's leather jacket.

On ABC's *Women's Murder Club*, a medical examiner directs her gaze to the crotch of a female corpse and says, "That's not your mama's bikini wax." On *The View*, Joy Behar said, "No pubic hair creates a wind tunnel." And in a hysterical episode of HBO's dark comedy series, *Curb Your Enthusiasm,* former *Seinfeld* producer Larry David performed oral sex on his wife, and in the process he sort of swallowed one of her pubic hairs. The next day, he was still choking on it, like a cat trying to get rid of a hairball.

A psychologist at Harvard Medical School and author of *Survival of the Prettiest: The Science of Beauty*, Nancy Etcoff, writes that "There's also an erotic, sexual component to hairlessness because your skin is more sensitive when it's more exposed. Women today are emulating porn stars who have no pubic hair, and I think men like it."

My own resistance to the plethora of bald pussies stems from my pre-adolescent days when pubic hair was such a big taboo that I became obsessed with it. In those pre-bikini days, I would go to Coney Island and stroll around the sand, sneaking glances at ladies in the hope of finding a few stray curlicues of forbidden pubic hair peeking out from their various and sun-dried crotches. And if I was able to discover any, why, it felt as though I had experienced a really productive afternoon.

Betty Dodson, sex educator and producer of *Viva La Vulva*, says, "I think we have changing ideas about what's public and what's private. And now that nudity is more public--nude beaches, routine nudity in film, and the enormous amount of exhibitionism and porn on the Web--I'm not surprised to see a trend toward pubic shaving. I think it's probably here to stay." She told me that, "Thanks to the lack of a comprehensive sex education for kids, young girls now want their vulvas to look like porn stars because that's what their boyfriends jerk off to and prefer. It's all they know." But a new study has concluded that pubic hair is returning: "The men don't care and the women don't can't bother."

Welcome back, good old bush. Hide and seek a friendly clit.

Ironically, although Arnold Schwarzenegger was only joking when he announced that *he* was going to get a Bikini wax, actually Beverly Hills skin care and waxing expert Nance Mitchell has about fifty regular male customers that come for pubic waxing who "are not gay and they are not porn stars. Some go totally bare, some just do the shaft and up around the pelvic area." She explains that "It depends on what their wives and girlfriends want. Men go along because removing the hair makes the whole package look bigger."

Ah, yes, the *illusion* of size does matter.

The Taste of Sperm

Online sexology columnist Sandor Gardos was asked, "How do I increase the amount of my ejaculate? I've noticed porn stars seem to ejaculate copious amounts of fluid, and I'd like to be able to wow my partner." Dr. Gardos points out that "the actors in porn films are professionals. Even they often don't ejaculate that much--sometimes movie makers will supplement with synthetic semen shot from a small tube."

Well, I'm just shocked to realize that somewhere in America there must be a group of scientists in a laboratory who earn their salaries by manufacturing fake semen.

Meanwhile, ManNotIncluded.com has become the first cyberspace sperm bank for lesbians and single women who want to become pregnant. They are matched with anonymous donors who have the desired race, eye color, height and weight, then sent instructions on how to inseminate themselves. John Gonzalez, founder of the website, hopes this service will overcome the hurdles presented by bureaucracies and fertility clinics who are prejudiced against same-sex couples.

"Lesbians hook up with gay men all the time," he says, "either friends or guys they've met through personal ads. We are now simply allowing them to do so safely and without discrimination."

On the other hand, in the movie, *Sarah Silverman: Jesus Is Magic*--a performance by one of the best and raunchiest female stand-up comedians--she describes a sure method of birth control: "coming all over her face." Of course, that punchline is derived from the ever popular image on Internet porn sites, where I look in vain for the small print with messages warning, "Do Not Try This Particular Money Shot At Home" and "This Is Not Exactly What She Means When She Says She'd Like To Get a Facial For Her Birthday."

Furthermore, in Chelsea, Michigan, Book Crafters has refused to print *Baboon Dooley, Rock Critic*, a collection of John Crawford's comic strip, because his protagonist accidentally drinks from a glass of semen. He spits it out upon learning the content, only to be called a sexist, and challenged: "You'd expect a *woman* to drink it, right?" However, on CNN, author Hugh Prather was a guest, and the subject was couples. A caller revealed his problem: "The trouble is, when I come in her mouth, she can't really swallow it all." The anchor quickly hung up on this premature ejaculation.

Cartoonist Mary Lawton depicted a character saying, "I just found out that alfalfa sprouts smell like sperm. Does this mean I should practice safe salad?" Yet humorist Jacqueline Shtuyote tells me that "Sperm is basically tasteless. The truth should be out about this. Men seem to think that their white stuff is a culinary delight, yet I know of no culinary courses extolling the flavor of sperm. And if, as rumored, Jack-in-the-Box cooks occasionally spill their cum on an irritating customer's hamburger, how many of us would be pleased with the added ingredient?

"Why can't we find something that changes the flavor of cum? Then men could squirt red stuff that is raspberry flavored, or brown stuff that is chocolate flavored. Shy women could finally delight in swallowing their lover's cum. No sperm would ever be spit out again. There could be a pill to make cum taste like fast-food hamburgers. Maybe then we wouldn't mind if we found out that the secret sauce on top of Jack-in-the-Box hamburgers is, after all, sperm."

But let's not forget those who don't eat meat. They face an ethical dilemma--whether or not it's an acceptable practice for a vegetarian to give a blow job, and if so, is it all right to swallow? The general practice is that, yes, it's definitely okay to give a blow job because no animal is harmed in the process. And, yes, it's also okay to ingest the

sperm because it's a good source of protein, something that's often lacking when meat is removed from the diet.

Finally--and this could possibly be an urban legend--in a biology class at Harvard University, a professor was discussing the high glucose levels found in semen which give the spermatozoa all that energy for their journey. A female freshman raised her hand and asked, "If I understand you correctly, you're saying there is a lot of glucose, as in sugar, in semen?"

"That's correct," replied the professor.

The student asked, "Then why doesn't it taste sweet?"

"It doesn't taste sweet," he answered as she realized what her question implied. She blushed, picked up her books and headed for the door, as he continued, "because the taste buds for sweetness are on the tip of your tongue and not the back of your throat. Have a good day."

Eating Shit for Fun and Profit

I am in complete awe of the democracy of the Internet, which presents an infinite menu for individual tastes and ideologies, and in this context, specifically to viewers of online pornography. From golden showers to farm animals, the World Wide Web caters to virtually every imaginable desire. With the privacy provided by a computer screen, you can worship at the fetish of your choice. But, in the process of surfing porn sites—for research purposes only, of course—I realized that I had never come across a site specializing in coprophagia. It means eating shit. Literally.

There's an old saying among nutritionists: "You are what you eat." However, comedian Darryl Henriques, playing the role of a New Age swami, says, "You are what you don't shit."

One of the nastiest things you can say to someone is, "Eat shit." A nonfiction book, *The Pit*, reveals a strange cult in San Francisco where a group of successful businessmen were forced, along with other acts of humiliation, to eat their own shit. Ultimately, they were represented in a lawsuit by flamboyant attorney Melvin Belli. But that was more-or-less

involuntary shit eating, and what we're talking about here is the voluntary kind.

For many years I heard stories that comic actor Danny Thomas, the star of *Make Room for Daddy*, was a coprophagiac. I assumed it was just another urban legend until I bumped into an old friend who was now working as a prostitute in Hollywood. Over lunch, she mentioned the names of some of her celebrity clients, including Danny Thomas. She told me how he had hired her to save her solid waste in her panties so that he could rub those panties on his face and gobble up her shit as though it were cotton candy.

When he finished, he would wash his hands and face thoroughly then pay her and, as if coming out of a trance, he'd say, "Where was I?" He was trying to distance himself from what he had just done. Instant denial. Since then, I have believed that Danny Thomas's fundraising for Saint Jude's Hospital was really for the purpose of having secret access to their bedpans.

Anyway, I googled "eating shit." Topping the list was "Shit Eating Grins: In Defense of Adam Sandler." But sure enough, I was soon led to hardcore shit-eating sites, which I found totally disgusting, yet absolutely riveting. You may not want to read any further, but we both know you will.

There are photos of beautiful women shitting. If you click for a close-up you can spot a yellow kernel of corn in one big brown chunk o' shit. Women are spreading shit all over their naked bodies and inside their vaginas. A pair of lovely lesbians are eating handfuls of shit, then tongue kissing each other. Two women are eating the same lengthy turd, starting from opposite ends. A woman, fully dressed, wearing a mini-skirt, is shitting as she walks along the sidewalk. One woman is shitting into another woman's mouth. Mmmm, good to the last dingleberry.

Among the shit-eating sites, there are Asian movies. Here's a couple of descriptions: "A bunch of kinky Japanese guys find some truly hot looking girls and take them down below the streets of Tokyo into a real sewer full of shit." And "Cute Kyoko's diarrhea suddenly acts up again. Her piano teacher becomes a willing student of hot scat games. Lots of shit pours out of her hot ass into his waiting mouth. Then she asks if he would rub it all over her. 'Sure, why not,' he says."

If there is one particular image that remains in my mind's eye, it is an innocent-looking, attractive teenager—she's over 18, of course—and she is cheerfully drinking a shit shake through a straw in an old-fashioned, malted-milk glass.

I thought about her father discovering that video in cyberspace, yet he is unable to confront his daughter about it because he would then have to admit what *he* was doing at that site. I mean, this isn't exactly the type of thing that would be mass emailed by one of those selfless spammers, is it? And even if the father did confess to his daughter, he would undoubtedly hesitate to ask if he could eat *her* shit, because that could be considered a form of incest, and you have to draw the line somewhere, right?

There must be an especially strong bond among coprophagiacs, though, because they have experienced in common a form of liberation from a taboo that can be traced all the way back to infancy, when a parent would cringe and say, "Stop! Don't eat that! I said *no!*"

Who knows, some day coprophagia might even become a religion?

Holy shit!

"I Fuck Dead People"

You don’t see many porn sites that feature intercourse with corpses, and if you do, how do you know they’re really dead? But, say what you will about California Governor Arnold Schwarzenegger, you have to give him credit for signing a bill to forbid necrophilia. Under the new law, sex with a corpse is now a felony punishable by up to eight years in prison.

Age is no barrier. The state’s first attempt to outlaw necrophilia--in response to a case of a man charged with having sex with the corpse of a 4-year-old girl in Southern California---stalled in a legislative committee, but the bill was revived after an unsuccessful prosecution of a man who was found in a San Francisco funeral home, passed out on top of an elderly woman’s corpse.

Necrophiliacs have been getting away with it all this time, but district attorneys will no longer be stymied by the lack of an official ban. According to Tyler Ochoa, a professor at Santa Clara University of Law who has studied California cases involving allegations of necrophilia, “Prosecutors didn’t have anything to charge these people with other than breaking and entering. But if they worked in a mortuary in the first place, prosecutors couldn’t even charge them with that.”

Whether necrophilia is a victimless crime may still be open to debate. Nevertheless, claiming that the act was consensual will not be considered as a legal defense. It should be noted that the necrophilia community ranges from those who are monogamous and stick with one partner for a lifetime, to those who are promiscuous and hop from casket to casket.

According to his own journal entry, Ralph Waldo Emerson, one of the most revered figures in American literary history, was so devastated by the death of his young wife, Ellen, that, shortly after her burial, he went out to the cemetery one night and dug up her corpse, though he didn't mention exactly what he did with it.

One of the most popular episodes of the police TV show, *Homicide, Life On the Streets*, was about the investigation of an old lonely widower, a mortician, who used to party with the corpses, setting them around a table as if they were alive. They investigated him because he shot a neighbor who knew about this practice, and then sat in the garden and waited for the cops. But again, the mortician's relationship with those corpses may have been purely platonic.

Let us now eavesdrop on the dialogue of a few participants in an Internet support group, Necrophiliacs Anonymous:

"Obviously, neither a corpse nor a 4-year-old can provide consent, but if you leave permission in your will for your lonesome spouse or significant other to have one last fling with your mortal coil, shouldn't the state of California respect your wishes?"

"I still think that organ donation is a better cause. It's just that I believe the only offense here is really violation of private property. I wonder if someone gives their partner, in a will, the right to have sex with their body after their death, will it be legal?"

"Or, even without that permission, if you are an only heir of somebody, doesn't it mean their body belongs to you? It sounds gross, but isn't it an issue of private rights in the United States of America, that likes so much the idea of individualism and is ready to exploit people and the environment in the name of that ideal?"

"I never understood why people think that having sex with a dead body is worse than raping a living person. To me, that's the worst kind, and then raping poor helpless animals. I really couldn't care less about my *own* dead body."

Conversely, Sam Kinison, the late evangelist who turned into a comedian, had a great routine about necrophilia: "Well, that's it, man--I'm dead. Nothing else bad can happen to me now. Wait a minute--

what' s that? What' s this guy doing? What' s going on here? [*Screams*] Oh oh oh oh oh OH OH OH OH OH *OOOOOOHHHHHH NOOOOOOO!!! Live in Hell!!!"*

The majority of cannibalistic serial killers are motivated by a kind of necrophilia--it' s usually a highly sexually arousing experience for them when they eat their victims. Here, from my "Great Moments in Necrophilia" file, is a dispatch from Associated Press:

"The prosecution in the insanity trial of serial killer Jeffrey Dahmer rested its case. Dahmer has confessed to killing and dismembering 17 young males since 1978. A jury must decide if he will be sent to prison or a mental institution. The final prosecution witness, Dr. Park Dietz, a psychiatrist, testified that Dahmer wore condoms when having sex with his dead victims, showing that he could control his urge to have intercourse with corpses."

I smell a public service announcement there: "If Jeffrey Dahmer is sane enough to have safe sex, what about *you*?"

COMEDIANS

Remembering Lenny Bruce

August 3rd, 2016 marked the 50th anniversary of groundbreaking comedian Lenny Bruce's death from an overdose of morphine, while his New York obscenity conviction at Café Au Go Go was still on appeal. On that same day he received a foreclosure notice at his Los Angeles home.

But it wasn't a suicide. In the kitchen, a kettle of water was still boiling, and in his office, the electric typewriter was still humming. He had stopped typing in mid-word: "Conspiracy to interfere with the 4th Amendment const" ...constitutes what, I wondered.

Lenny was a subscriber to my satirical magazine, *The Realist,* and in 1959 we met for the first time at the funky Hotel America in Times Square. He was amazed that I got away with publishing those profane words for which other periodicals used asterisks or dashes. He had been using euphemisms like "frig" and asked, "Are you telling me this is legal to sell on the newsstands?"

I replied, "The Supreme Court's definition of obscenity is that it has to be material which appeals to your prurient interest." He magically produced an unabridged dictionary from the suitcase on his bed, and looked up the word "prurient." He closed the dictionary, clenching his

jaw and nodding his head in affirmation of a new discovery. "So," he observed, "it's against the law to get you horny."

When we were about to leave the room, he stood in the doorway. "Did you steal anything?" he asked furtively. I took my watch out of my pocket since I didn't like to wear it on my wrist, and without saying a word I placed it on the bureau. Lenny laughed one loud staccato "Ha" and kissed me on the forehead.

We developed a friendship integrated with stand-up comedy. In his act Lenny had broken through traditional stereotypical jokes about airplane food, nagging wives, Chinese drivers, annoying mothers-in-law. Instead he weaved his taboo-breaking targets--teachers' low salaries *versus* show-business celebs, religious leaders' hypocrisy, cruel abortion laws, racial injustice, the double standard between illegal and prescription drugs--into stream-of-consciousness vignettes.

In each succeeding performance, he would sculpt and re-sculpt his concept into a theatrical context, experimenting from show to show like a verbal jazz musician. Audience laughter would sometimes turn into clapping for the creative process itself. "Please don't applaud," he'd request. "It breaks my rhythm."

Lenny was writing an autobiography--*How to Talk Dirty and Influence People*--which *Playboy* planned to serialize, then publish as a book, and they hired me as his editor. We met in Atlantic City, where he was taking Delaudid for lethargy, and he sent a telegram to a contact, with a phrase--DE LAWD IN DE SKY--as a code to send a doctor's prescription.

At a certain point he was acting paranoid and demanded that I take a lie-detector test, and I was paranoid enough to take him literally. I couldn't work with him if he didn't trust me. We got into an argument, and I left.

He sent a telegram that sounded like we were on the verge of divorce. "WHY CAN'T IT BE THE WAY IT USED TO BE?" he wrote. I agreed to try again, and in 1962 I flew to Chicago. Lenny was performing at the Gate of Horn, where he was asking the whole audience to take a lie-detector test.

Lenny was intrigued by the implications of an item in *The Realist,* an actual statement by Adolf Eichmann that he would have been "not only a scoundrel, but a despicable pig" if he hadn't carried out Hitler's orders. Lenny wrote a piece for *The Realist,* "Letter From a Soldier's Wife," namely Mrs. Eichmann pleading for compassion to spare her husband's life.

Lenny had been reading a study of anti-Semitism by Jean-Paul Sartre. Now, on stage, giving credit to Thomas Merton's poem about the Holocaust, he requested that all the lights go off except one dim blue spot. Then he began speaking with a German accent:

> My name is Adolf Eichmann. And the Jews came every day to what they thought would be fun in the showers. People say I should have been hung. *Nein*. Do you recognize the whore in the middle of you–that you would have done the same if you were there yourselves? My defense: I was a soldier. I saw the end of a conscientious day's effort. I watched through the portholes. I saw every Jew burned and turned into soap.
>
> Do you people think yourselves better because you burned your enemies at long distance with missiles without ever seeing what you had done to them? Hiroshima *auf Wiedersehen*. [*German accent ends*.] If we would have lost the war, they would have strung Truman up by the balls, Jim. Are you kidding with that? Not what kid told kid told kid. They would just *schlep* out all those Japanese mutants. "Here they did; there they are." And Truman said they'd do it again. That's what they should have the same day as Remember Pearl Harbor. Play them in unison.

Lenny was arrested for obscenity that night. One of the items in the Chicago police report complained: "Then talking about the war he stated, 'If we would have lost the war, they would have strung Truman up by the balls.' " The cops also broke open Lenny's candy bars, looking for drugs. They checked the IDs of audience members, including George Carlin, who told the cops, "I don't believe in IDs." Then they arrested him for disorderly conduct, dragged him along by the seat of his pants and hoisted him into the police wagon.

"What are you doing here?" Lenny asked.

"I didn't want to show them my ID."

"You schmuck."

Lenny was released on bail, but the head of the Vice Squad warned the Gate of Horn manager: "If this man ever uses a four-letter word in this club again, I'm going to pinch you and everyone in here. If he ever speaks against religion, I'm going to pinch you and everyone in here. Do you understand? You've had good people here. But he mocks the pope--and I'm speaking as a Catholic--I'm here to tell you your license is in danger. We're going to have someone here watching every show."

And indeed, the Gate of Horn's liquor license was suspended. There were no previous allegations against the club, and the current charge involved neither violence nor drunken behavior. The only charge pressed by the city prosecutor was Lenny Bruce's allegedly obscene performance. Nobody's prurience was aroused, but that made no difference. After all, there wasn't any law against blasphemy.

"Chicago is so corrupt, it's thrilling," Lenny said.

Chicago had the largest membership in the Roman Catholic Church of any archdiocese in the country. Lenny's jury consisted entirely of Catholics. The judge was Catholic. The prosecutor and his assistant were

Catholic. On Ash Wednesday, the judge removed the spot of ash from his forehead and told the bailiff to instruct the others to do likewise. The sight of a judge, two prosecutors and twelve jurors, every one with a spot of ash on their foreheads, would have all the surrealistic flavor of a Lenny Bruce fantasy.

Since he often talked on stage about his environment, and since police cars and courtrooms had become his environment, the content of Lenny's performances began to revolve more and more around the inequities of the legal system. "In the Halls of Justice," he declared, "the only justice is in the halls." But he also said, "I love the law." Instead of an unabridged dictionary, he now carried law books in his suitcase. His room was cluttered with tapes and transcripts and photostats and law journals and legal briefs.

Once he was teasing his ten-year-old daughter, Kitty, by pretending not to believe what she was telling him. "Daddy," she said, "you'd believe me if it was on tape."

Lenny's jazz jargon was gradually being replaced by legal jargon. He had become intimate not only with the statutes concerning obscenity and narcotics but also with courtroom procedure, and his knowledge would be

woven into his performances. But as clubs became increasingly afraid to hire him, he devoted more and more time and energy to the law.

In less than two years, Lenny was arrested 15 times. Club owners were afraid to book him. He couldn't get a gig in six months. On a Christmas day, he was alone in his hotel room, and I brought him a $500 bill. With a large safety pin, he attached it to his denim jacket. When he finally got a booking in Monterey, he admitted, "I feel like it's taking me away from my work."

Lenny lived way up in the hills. His house was protected by barbed wire and a concrete gate, except that it was always open. He had a wall-to-wall one-way mirror in his living room, but when the sun was shining you could see into the room instead of out. He was occasionally hassled by police on his own property. One evening in October 1963, we were talking while he was shaving, when four officers suddenly appeared, loud and obnoxious. He asked them to leave unless they had a search warrant.

One of the cops took out his gun. "Here's my search warrant," he said. Then Lenny and the cops had a discussion about the law, such as the rules of evidence, and after half an hour they left. Lenny tried to take it all in stride, but the encounter was depressing, and he changed his mind about going out that night.

When everything was quiet, we went outside and stood at the edge of his unused swimming pool. Dead leaves floated in the water. Lenny cupped his hands to his mouth. "All right, you dogs," he called out. "Bark for the rich man!" --thereby setting off a chain reaction of barking dogs, a canine chorus echoing through Hollywood Hills.

We ordered some pizza, and he played some old tapes, ranging from a faith healer to patriotic World War II songs. "Good-bye, Mama, I'm off to Yokohama, the Land of Yama-Yama..."

Back at the Café Au Go Go arrest in New York, Lenny had told a fantasy tale about Eleanor Roosevelt, quoting her, "I've got the nicest tits that have ever been in this White House…" The top of the police complaint was "Eleanor Roosevelt and her display of tits." At the trial, Lenny acted as his own attorney. He had obtained the legislative history of an Albany statute, and he discovered that back in 1931 there was an amendment proposed, which excluded from arrest in an indecent performance: stagehands, spectators, musicians, and--here was the fulcrum of his defense--actors. The law had been misapplied to him. Despite opposition by the New York Society for the Suppression of Vice, the amendment was finally signed into law by then-Governor Roosevelt, but to no avail.

"Ignoring the mandate of Franklin D. Roosevelt," Lenny observed, "is a great deal more offensive than saying Eleanor has lovely nay-nays."

On October 13, 1965 (Lenny's 40th birthday), instead of surrendering to the authorities in New York, he filed suit at the U.S. District Court in San Francisco to keep out of prison, and he got himself officially declared a pauper. Two months before his death in 1966, Lenny wrote to me: "I'm still working on the bust of the government of New York State." And he included his doodle of Christ nailed to a crucifix, with a speech balloon asking, "Where the hell is the ACLU?"

After he died, at a séance, his mother brought his old faded denim jacket. That large safety pin was still attached to it. And at the funeral, his sound engineer friend dropped Lenny's microphone into his grave before the dirt was piled on. Lenny's problem had been that he wanted to talk on stage with the same freedom that he had in his living room. That problem doesn't happen to stand-up comedians any more.

As for me, I'm working on my long awaited (by me) first novel. It's about a contemporary Lenny Bruce-type satirist. Those scenes where my protagonist performs, I've developed onstage myself, although at times it felt like I was actually channeling Lenny, until the day that he said, "C'mon, Paul,

you know you don't believe in that shit." Well, this ended *that* wishful-thinking delusion.

I told my friend Avery Corman--author of *Oh, God* and *Kramer vs. Kramer*-- how I welcomed the challenge of writing fiction.

"But, you know," I added, "it's really hard to write. You have to make everything up."

And he said, "Hey, listen, you've been making stuff up all your life."

"Yeah, but that was journalism."

My Acid Trip With Groucho Marx

LSD was influencing music, painting, spirituality, and even the stock market. Tim Leary once let me listen in on a call from a Wall Street broker thanking him for turning him onto acid because it gave him the courage to sell short. Leary had a certain sense of pride about the famous folks he and his associates had introduced to the drug.

"But," he told me, "I consider Otto Preminger one of our failures."

I first met Preminger in 1960 while I was conducting a panel on censorship for *Playboy.* He had defied Hollywood's official seal of approval by refusing to change the script of *The Moon Is Blue*. He wouldn't take out the word *virgin*.

At the end of our interview, he asked, "Ven you tronscripe dis, vill you vix op my Henglish?"

"Oh, sure," I replied quickly. "Of course."

"Vy? Vot's drong viz my Henglish?"

I saw Preminger again in 1967. He was making a movie called *Skidoo*, starring Jackie Gleason as a retired criminal. Preminger told me he had originally intended that role for Frank Sinatra. *Skidoo* was pro-acid

propaganda thinly disguised as a comedy adventure. However, LSD was not why the FBI was annoyed with the film. Rather, according to Gleason's FBI files, the FBI objected to one scene in the script where a file cabinet is stolen from an FBI building. Gleason was later approved as a special FBI contact in the entertainment business.

One of the characters in *Skidoo* was a Mafia chieftain named God. Screenwriter Bill Cannon had suggested Groucho Marx for the part. Preminger said it wasn't a good idea, but since they were already shooting, and that particular character was needed on the set in three days, Groucho would be playing God after all. During one scene, Preminger was screaming instructions at him. Groucho yelled back, "Are you drunk?"

I had dinner with him that evening. He was concerned about the script of *Skidoo* because it pretty much advocated LSD, which he had never tried, but he was curious. Moreover, he felt a certain responsibility to his young audience not to steer them wrong. He had read my descriptions of acid trips, so he asked if I could I possibly get him some pure stuff, and would I care to accompany him on a trip? I did not play hard to get. We arranged to ingest those little 300-microgram white tablets one afternoon at the home of an actress in Beverly Hills.

Groucho was especially interested in the countercultural aspects of LSD. I mentioned a couple of incidents that particularly tickled him, and his eyes sparkled with delight. One was about how, on Haight Street, runaway youngsters, refugees from their own families, had stood outside a special tourist bus–guided by a driver "trained in sociological significance" --and they held mirrors up to the cameras pointing at them from the windows, so that the tourists would get photos of themselves trying to take photos.

The other was about the day that LSD became illegal. In San Francisco, at precisely two o'clock in the afternoon, a cross-fertilization of mass protest and tribal celebration had taken place, as several hundred young people simultaneously swallowed tabs of acid while the police stood by helplessly

"Internal possession wasn't against the law," I explained to Groucho.

"And they trusted their friends more than they trusted the government," he said. "I like that."

We had a period of silence and a period of listening to music. I was accustomed to playing rock' n' roll while tripping, but the record collection at this house consisted entirely of classical music and Broadway show albums. First, we listened to the "Bach Cantata No. 7." "I'm

supposed to be Jewish," Groucho said, "but I was seeing the most beautiful visions of Gothic cathedrals. Do you think Bach *knew* he was doing that?"

"I don't know. I was seeing beehives and honeycombs myself."

Later, we were listening to the score of a musical comedy, *Fanny*. There was one song called "Welcome Home," where the lyrics go something like, "Welcome home, says the clock," and the chair says, "Welcome home," and so do various other pieces of furniture. Groucho started acting out each line, as though he were actually *being* greeted by the clock, the chair, and the rest of the furniture. He was like a child, charmed by his own ability to respond to the music that way.

There was a bowl of fruit on the dining room table. During a snack, he said, "I never thought eating a nice juicy plum would be the biggest thrill of my life." Then we talked about the sexual revolution. Groucho asked, "Have you ever laid two ladies together?"

I told him about the time that I was being interviewed by a couple of students from a Catholic girls' school. Suddenly Sheila, *The Realist*'s "Scapegoat," and Marcia, the "Shit-On" --she had given herself that title because "What could be lower than a Scapegoat?" --walked out of their office totally nude. "Sorry to interrupt, Paul," said Sheila, "but it's

Wednesday--time for our weekly orgy." The interviewers left in a hurry. Sheila and Marcia led me up the stairs to my loft bed, and we had a delicious threesome. It had never happened before, and it would never happen again.

At one point in our conversation, Groucho somehow got into a negative space. He was equally cynical about institutions, such as marriage--"legal quicksand"--and individuals, such as Lyndon Johnson, referred to as "that potato-head."

Eventually, I asked, "What gives you hope?"

He thought for a moment. Then he just said one word: "People."

I told him about the sketch I had written for Steve Allen, "Unsung Heroes of Television," with the man whose job it was on *You Bet Your Life* to wait for the secret word to be said so that he could drop the duck down, and Groucho told me about one of his favorite contestants on the show. "He was an elderly gentleman with white hair, but quite a chipper fellow. I asked him what he did to retain his sunny disposition. 'Well, I'll tell you, Groucho,' he says, 'every morning I get up and I *make a choice* to be happy that day.'"

Groucho was holding onto his cigar for a long time, but he never smoked it, he only sniffed it occasionally. "Everybody has their own Laurel

and Hardy," he mused. "A miniature Laurel and Hardy, one on each shoulder. Your little Oliver Hardy bawls you out--he says, 'Well, this is a *fine mess* you've gotten us into.' And your little Stan Laurel gets all weepy–--Oh, Ollie, I couldn't help it. I'm sorry, I did the best I could.' "

Later, when Groucho started chuckling to himself, I hesitated to interrupt his reverie, but I had to ask, "What struck you funny?"

"I was thinking about this movie, *Skidoo*," he said. "I mean some of it is just plain ridiculous. This hippie inmate puts a letter he got, which is soaked in LSD, into the water supply of the prison, and suddenly everybody gets completely reformed. There's a prisoner who says, 'Oh, gosh, now I don't have to be a rapist any more!' But it's also sophisticated in its own way. I like how Jackie Gleason, the character he plays, *accepts* the fact that he's not the biological father of his daughter."

"Oh, really? That sounds like the ultimate ego loss."

"But I'm really getting a big kick out of playing somebody named God like a dirty old man. You wanna know why?"

"Typecasting?"

"No, no--it's because--do you realize that irreverence and reverence are the *same thing?*"

"Always?"

"If they're not, then it's a misuse of your power to make people laugh." His eyes began to tear. "That's funny. I'm not even sad." Then he went to urinate, and when he came back, he said, "You know, everybody is waiting for *miracles* to happen. But the whole *human body* is a goddamn miracle." He recalled Otto Preminger telling him about his own response to taking LSD and then he mimicked Preminger's accent: "I saw *tings*, bot I did not zee myself." Groucho was looking in a mirror on the dining room wall, and he said, "Well, I can see *my*self, but I still don't understand what the hell I'm *doing* here . . ."

A week later, Groucho told me that members of the Hog Farm commune who were extras in the movie had turned him on with marijuana on the set of *Skidoo*. "You know," I said, "my mother once warned me that LSD would lead to pot." "Well," he said, " your mother was right."

When *Skidoo* was released, Tim Leary saw it, and he cheerfully admitted, "I was fooled by Otto Preminger. He's much hipper than me."

In 1971, during an interview with *Flash* magazine, Groucho said, "I think the only hope this country has is Nixon's assassination." Yet he wasn't subsequently arrested for threatening the life of a president. In view of the indictment against Black Panther David Hilliard for using similar

rhetoric, I wrote to the Justice Department to find out the status of their case against Groucho, and received this reply:

> Dear Mr. Krassner:
>
> Responding to your inquiry, the Supreme Court has held that Title 18 U.S.C., Section 871, prohibits only "true" threats. It is one thing to say that "I (or *we*) will kill Richard Nixon" when you are the leader of an organization which advocates killing people and overthrowing the Government; it is quite another to utter the words which are attributed to Mr. Marx, an alleged comedian. It was the opinion of both myself and the United States Attorney in Los Angeles (where Marx's words were alleged to have been uttered) that the latter utterance did not constitute a "true" threat.
>
> Very Truly Yours,
> James L. Browning, Jr.
> United States Attorney

It would later be revealed that the FBI had published pamphlets in the name of the Black Panthers, advocating the killing of cops, and that an FBI file on Groucho Marx had indeed been started, and he actually *was* labeled a "national security risk." I phoned Groucho to tell him the good news.

"I deny everything," he said, "because I lie about everything." He paused, then added, "And everything I *deny* is a lie."

The last time I saw Groucho was in 1976. He was speaking at the Los Angeles Book Fair. He looked frail and unsmiling, but he was alert and irascible as ever. He took questions from the audience.

"Are you working on a film now?"

"No, I'm answering silly questions."

"What are your favorite films?"

"*Duck Soup*. *Night at the Opera*."

"What do you think about Richard Nixon?"

"He should be in jail."

"Is humor an important issue in the presidential campaign?"

"Get your finger out of your mouth."

"What do you dream about?"

"Not about you."

"What inspired you to write?"

"A fountain pen. A piece of paper."

Then I called out a question: "What gives you the most optimism?"

I expected him to say "People" again, but this time he said, "The world."

There was hardly any standing room left in the auditorium, yet one fellow was sitting on the floor rather than take the aisle seat occupied by a large Groucho Marx doll.

Remembering George Carlin

George Carlin died in June 2008. He was a generous friend. When I performed in Los Angeles, he sent a limousine to pick me up at the airport, and I stayed at his home. And such a sweet man. When I opened for him at the Warner-Grand Theater in San Pedro, we were hanging around in his dressing room, where he was nibbling from a vegetable plate. I watched as he continued to be genuinely gracious with every fan who stopped by. If they wanted his autograph, he would gladly sign his name. If they wanted to be photographed with him, he would assume the pose. If they wanted to have a little chat, he indulged them with congeniality.

I said, "You really show respect for everybody."

"Well," he responded, "that's just the way I would want to be treated."

As a performer, Carlin was uncompromising, knowing that his audience trusted him not to be afraid of offending them. In fact, he was excited by that possibility. The day before one of his live HBO specials, he called and told me to be sure and watch it, because he would devote the first ten minutes of his performance to the subject of abortion.

Carlin had long been vocal in support of the right to smoke and ingest various drugs, and he posed this rhetorical question: "Why are there no recreational drugs in suppository form?" I was pleased to inform him that teenage girls have been experimenting with tampons soaked in vodka, inserting them vaginally or rectally as a way of getting intoxicated without their parents detecting booze on their breath.

No matter what else Richard Nixon accomplished in his lifetime, his obituaries always mentioned him as the first American president to resign, and no matter what else George Carlin accomplished in *his* lifetime, his obits always connected him with the Supreme Court ruling on "The Seven Words You Can't Say on Television."

When asked in the Green Room at the Warner-Grand Theater by producer Dan Pasley why he didn't include the word "nigger" in that list, Carlin replied, "There's nothing funny about it -- that really *is* a dirty word -- but repressed words about sexual functions and bodily parts were truly funny. I had only been thinking about the 'dirty' words in terms of sex and bodily functions, and how uptight these religious freaks have made us. *That's* fun, that's some funny shit."

At a private memorial for family and friends, Carlin's daughter Kelly read from his burial instructions, written on May 1, 1990:

Upon my death, I wish to be cremated. The disposition of my ashes (dispersal at sea, on land or in the air) shall be determined by my surviving family (wife and daughter) in accordance with their knowledge of my prejudices and philosophies regarding geography and spirituality. Under no circumstances are my ashes to be retained by anyone or buried in a particular location. The eventual dispersal can be delayed for any reasonable length of time required to reach a decision, but not to exceed one month following my death.

I wish no public service of any kind. I wish no religious service of any kind. I prefer a private gathering at my home, attended by friends and family members who shall be determined by my surviving family (wife and daughter). It should be extremely informal, they should play rhythm and blues music, and they should laugh a lot. Vague references to spirituality (secular) will be permitted.

Kelly added, "There will be no mention of God allowed" and "No one will be allowed to say that 'George is now smiling down at us from Heaven above.' "

Carlin once told an audience of children how to be a class clown as a way of attracting attention. "I didn't start out with fake heart attacks in the aisle," he explained. Ah, if only that's what he was doing *this* time.

But a reporter did once ask him how he wanted to die.

"I'd like to explode spontaneously in someone's living room," he replied. "That, to me, is the way to go out."

And, through his CDs, DVDs, books, and online, George Carlin does indeed continue to explode spontaneously in living rooms across the country and around the world. **Roasting With Robin**

The first time I met Robin Williams was in 1976 at the first annual Comedy Competition in San Francisco. He was sweating profusely, his hairy chest and arms showing, and he wore a brown cowboy hat. I was one of the judges. Although I voted for Williams, he came in second.

I forget the winner's name, but I recall that the lights went off in the middle of his act, so he took advantage of the accident, and in the darkness he whispered loudly, "Okay, now, when the lights go back on, everybody shout out, 'Surprise! Surprise!'" The audience laughed and applauded that ad lib.

Robin's disappointment was palpable, but his stardom was inevitable. Our paths continued to cross backstage at benefits where we both performed. He was also a reader of *The Realist*. In 1988, the word got around that I was going to undergo surgery, and he sent me a generous unsolicited check to help.

In 1998, Anita Hoffman, Abbie's widow, dying from cancer, decided to take her life on December 27, so as not to spoil Christmas for family and friends who were visiting and bringing all kinds of food. Her appetite was ravenous, and her humor was dark. After devouring a pastrami sandwich, she remarked, "I better brush my teeth, I don't want to get gum pockets."

She was staying at a house in San Francisco owned by actress Wynona Rider, whose godfather was Timothy Leary. He had been Anita's role model during the final months of *his* life. "You couldn't choose how and when and with whom you were *born,"* he said, "but you can take charge of your own death." And that's exactly what she was now doing.

Robin Williams learned about Anita's situation from his co-star in *Good Will Hunting,* Matt Damon, who had been told about it by his girlfriend, Wynona. Robin had never met Anita, but he called and offered to pay a visit, in keeping with his benign case of Patch Adams Syndrome. After all, if Patch could travel to Trinidad to entertain murderers who would be hanged three days later, why shouldn't it be appropriate for Robin to make Anita laugh on Christmas day? She hesitated— "I've never really been a fan of his work," she thought—but then invited him to visit....

And so it came to pass in 2014 that Robin Williams would also commit suicide. In the midst of mass mourning him, Rush Limbaugh explained that "Leftists are never happy." And the anti-choice *Lifenews* claimed that Robin killed himself out of guilt over an abortion his girlfriend had in the 1970s.

The last time I saw him was in 1987 on a Saturday evening at the Hollywood Press Club, where we were both participants at a roast for Harlan Ellison, the prolific author of fantasy, science-fiction and speculative-fiction, his work including 1,700 short stories. He also had a reputation for angry ranting with literary style. My wife Nancy said, "He has a black belt in Mouth."

The roast was supposedly a fundraiser for his defense in a frivolous libel lawsuit. Although the auditorium was filled at $25 a head, the plaintiff, Michael Fleischer, was suing Ellison for a million dollars. In a 1980 issue of *Comics Journal*, in a review of Fleischer's comic-book-novel, Ellison called him "crazy" like H.P. Lovecraft and other renowned writers. Ironically, Harlan had intended it to be a compliment.

Screenwriter David Gerrold remarked, "The fact that Ellison is a self-made man relieves God of a great responsibility. I've been Harlan's friend for six years. Of course, I've known him for eighteen years."

The moderator of the roast, film critic Digby Diehl, read a telegram from Isaac Asimov, which concluded, "Kick him in the balls—signed, Frank Sinatra." Onstage, Asimov's fellow science-fiction writer Robert Silverberg announced that "Harlan Ellison is so short that he goes up on

his girlfriend." Robin and I were sitting next to each other, and we simultaneously crossed that joke off our imaginary lists.

There were short-jokes galore. Have a few free samples: "Short? I carry a life-sized portrait of Harlan in my wallet." "Harlan's parents were normal, but the milkman was a syphilitic dwarf." And the producer of *Twilight Zone,* Phil de Guere, complained, "It took Harlan nine months before he figured out how to shoot himself in the foot at *Twilight Zone* and get canned. But of all the people I have worked with, Harlan is by far the shortest. Harlan doesn't have a short fuse. He *is* a short fuse."

My own short-joke was, "Actually, this isn't a roast. It's more like a microwave." Robin said, "Harlan is a tall Paul Williams, a white Paul Simon." I pointed out that "Harlan is on the right side of a lot of important fights. He's fought against racism and sexism. That's why this whole panel is white males."

A roast by definition overflows with irreverence, insults, and raunchiness. Examples: "If it's true that you are what you eat, Harlan would be a vagina." Stan Lee of comic-book infamy said, "Harlan is a very difficult person to arouse. Ask any of his former wives." And Robin contributed a metaphorical dick joke: "If you're hung like a field mouse, don't stand in the wind."

I stated that "Harlan is an egomaniac partially because at the moment of sexual climax, he calls out his own name." Robin shouted: "Was it good for *me?*" I responded, "Harlan has a typewriter with only two letters—M and E. And on it he has somehow managed to write 42 books as well as 300 of Steve Allen's songs plus a few of Lyndon LaRouche's speeches."

Robert *Psycho* Block remembered when "Harlan was interested in re-writing other people's work. He took me into a nearby drugstore and showed me how he had erased all the M's
off all the Murine bottles." I observed that "Harlan has always refused to get involved with the drug world—as a user. However, he *is* a dealer. In fact, he was the connection for Kathy Evelyn Smith."

A severe groan emanated from the audience, and I realized that I was treating a roaster as a roastee, not an uncommon practice. Robin Williams and Robert DeNiro had been with Smith and John Belushi on the night of Belushi's death. "Oh, that's a good one," Robin said with understandable Sarcasm 101. "Listen," I replied, "if she didn't plea-bargain, you wouldn't be here tonight."

Moderator Digby Diehl proceeded to rub salt in Robin's wound that I had unintentionally caused: "Robin Williams has been called the

king of improv, and he has proven it tonight by interrupting everybody, stepping on their lines, doing schtick. He's been about as annoying he can be."

"I loved that review, though," said Robin, referring to Diehl's negative critique of *Club Paradise.*

Diehl: "I was hoping you hadn't seen it, Robin. It's said of you in Hollywood that you don't read your scripts. Anyway, ladies and gentlemen, I'd like to bring you Robin Williams, fresh from *Club Paradise,* his biggest failure yet."

Williams: "Thank you, Gary Franklin [the movie reviewer Diehl replaced]. What can you say about a man who's a TV critic? A man who looks at a good film and letters it like a report card. Is that art? I think not. And I'd like to thank Harlan's lawyer for proving, God, is there a reason for law? I think not. And I'd like to thank Mr. Krassner for all the Kathy Smith references. That's some funny stuff."

Robin confessed, "I really don't know Harlan for shit," then described his house. "It's like Notre Dame done by Sears. There's Harlan, naked, playing in his toys with a beautiful shiksa goddess jumping up and down saying, 'I like him. He's smart.'" Robin morphed into a little boy in the bathroom. "I'm reading Bradbury, dad." (Roaster Ray

Bradbury chortled. Robin suppressed a fake sob.) "It's just taken me so far down to be here. I wish I could cry but I don't care." (The audience applauded.)

"Well," said Diehl, "it's been basically a really hostile, ugly night, with a lot of lame jokes and sentimental drivel. But we still have the ritual forgiveness to look forward to." He introduced Harlan Ellison, "a man with the milk of human kindness dripping from his fangs."

"Ha, ha. Very funny, I'm sure," Harlan reacted. "I had a friend once, but the wheels fell off. Zip friends. Dust is my friend. And what of these fuckers here? Robin Williams can't even get a pair of pants that fits him."

"There's a reason for that, Harlan."

"Yeah, sure. It was for you they made up the phrase, 'Is it in yet?' You wanna talk about that, Williams? I've got four words for you: *Club Paradise* and *The Survivors."*

"Yeah, on a double bill with *Man With a Dog* [Ellison wrote the screenplay]."

Harlan continued to baste the roasters. As for me, he said, "I want to thank my old chum Krassner for being here tonight. I want to commend him on his restraint in the remarks he made. Or perhaps it was only

caution on his part because I promised if he fucked around with me, I'd let on that he caught his herpes from Nancy Reagan."

Digby Diehl concluded, "Harlan's only fear is that he'll get in a car accident and have to re-live this event. And in the true tradition of roasting, that tradition being to talk dirty and mention a big name, thank you all for coming. And join us next week when our guest roaster will be Mother Teresa."

I blurted out, "I fucked *her.*"

The audience screamed, hooted, stomped, and Robin jumped out of his chair and ran around in a circle. Then he said, "Gandhi is going, 'Who is this man? He may not get through the gates of heaven for that line.'"

Harlan said, "Thank God Krassner got off one good one."

I explained, "I guess I just fell into the insult mode."

"Basically," said Robert Silverberg, "the roast is a really ugly, repugnant, immature and childish art form. I hate it. And I will only do one if Harlan is the target."

And on our way home, Nancy summed up the irony: "A compliment was originally perceived as an insult, and consequently we've had an evening of insults which were really compliments."

Remembering Dick Gregory

I first met Dick Gregory when he asked me to interview him for *The Realist* in New York. I saw him again when I was in Chicago. He was performing at the Playboy Club and invited me to his show. Two years previously, Negro comedians performed only in Negro nightclubs, and Gregory was no exception.

But one evening the regular white comic at the Playboy Club got sick, and Gregory took his place. It made *Time* magazine, and he was invited to perform on the *Tonight Show*, but he declined unless, after doing his stand-up act, he would be asked to sit down and talk with Jack Paar. The gamble worked, and Gregory became an instant celebrity, breaking through the color barrier with humor.

Eventually we became friends and fellow demonstrators. Now he was performing at the Playboy Club, not as a substitute comic but as a star attraction. They had to supply me with a jacket, and a tie that was decorated all over with bunny symbols. Gregory was already on stage.

"How could Columbus discover America," he was asking the audience, "when the Indians were already *here?*"

In his dressing room between shows, Gregory took out his wallet and showed me a tattered copy of his favorite poem, "If," by Rudyard Kipling. I laughed and he looked offended, until I explained that I was laughing because it was also *my* favorite poem, and "the unforgiving minute" was my favorite poetic phrase.

Gregory visited me on the lower east side of New York. The entire side of one building on that block featured a fading advertisement for a cleanser personified by the Gold Dust Twins, a pair of little Negro boys. It had originally been painted right on the bricks.

When he saw it, he said, "They ought to take that whole wall and preserve it in a museum somewhere."

* * *

On a work-vacation in the Florida Keys with Abbie and Anita Hoffman in December in 1967. I followed a neighborhood crow down the road, then continued walking to town by myself to use the telephone. First I called Gregory, since it was his city Chicago that we were planning to invade the presidential convention in the 1968 summer. He told me that

he had decided to run for president, and he wanted to know if I thought Bob Dylan would make a good vice president.

"Oh, sure, but to tell you the truth, I don't think Dylan would ever get involved in electoral politics."

Gregory would end up with assassination researcher Mark Lane as his running mate. Next, I called Jerry Rubin in New York to arrange for a meeting when we returned.

At our counter-convention we all attended an Unbirthday Party for President Lyndon Johnson at the Coliseum, with Ed Sanders, leader of the Fugs, serving as emcee. The atmosphere was highly emotional. Dick Gregory recited the Preamble to the Declaration of Independence with incredible fervor. Fists were being upraised in the audience as he spoke, and I thrust my own fist into the air for the first time.

* * *

When my marriage broke up in 1971 I moved to San Francisco and I had my own talk program. Gregory announced on my show that, until the war in Vietnam was over, he was going to stop eating solid foods. I in turn announced that, until the war was over, I was going to eat all of Dick Gregory's meals. Actually, my only *real* discipline was being silent one day a week.

When my young daughter Holly came out to stay with me that summer, she decided to join me on my silent day. We communicated with handwritten notes. Holly wrote, *Does laughter count?* Since we were making up the rules as we went along, I answered, *Yes, but no tickling*. Naturally she tried to make me laugh, but I held it in – and got a rush.

All the energy that normally gets dissipated into the air with laughter seemed to surge through my body instead. I decided to stop laughing altogether, just to see what would happen. The more I didn't laugh, the more I found funny. And, paying closer attention to others, I refined my appreciation of laughter as another whole language that could often be more revealing than words. Sometimes I would get a twinge of guilt if I nearly slipped and laughed, and I remembered what I had always known, that children must be *taught* to be serious. When I mentioned my laugh-fast to Dick Gregory, still on his food-fast, it didn't sound so far-fetched to him.

That's two things people do out of insecurity," he said. "Eating and laughing."

"Well, what would happen to us if everyone in our audiences realized that?"

"Brother, we'd go out of business."

* * *

I was invited to a Christmas party in 1977 by *Hustler* publisher Larry Flynt. Gregory was at the party, and Flynt asked each of us to perform, but first he would take the microphone himself. To my surprise-shock that he wanted me to publish his magazine beside *The Realist* while he traveled around the country to spread his (temporary) born-again Chrisianity.

On Thanksgiving Day, Gregory had been arrested in front of the White House for protesting the lack of human rights in South Africa. Larry Flynt had a premonition that there would be an assassination attempt on Gregory. Flynt contacted him a couple of weeks later, and they became friends. Gregory was now staying at Flynt's mansion in Columbus, helping him change to a vegetarian diet. Flynt had already taken off forty pounds. On the day before the Christmas party, Gregory was in the middle of giving himself an enema when Flynt walked in.

According to Gregory, "Larry said, 'Let me tell you about this fantastic guy I've got comin' out, and I don't know what I'm gonna do yet but I just wanna talk with him.' And I said, 'Well, who is it?' He said, 'Paul Krassner.' And I just fell out, and said, 'Are you serious? He's one of the hippest minds in the whole world.' Then he came back and said,

'How long you been knowin' him?' and I told him, 'All through the sixties,' you know. And I said it was a fantastic idea."

For the New Year, Flynt flew Gregory and me to the Bahamas. Gregory was in the kitchen, diligently preparing a health drink for Flynt – this must have been the birth of his Bahamian Diet powder -– and he was also feeding unfiltered conspiracy theories to his eager student.

At midnight, we all went out on the dock and stood in a misty drizzle as Gregory uttered truly eloquent prayers for each of us. When he finished, Flynt's wife Althea whined, like Lucy in the *Peanuts* strip, "My hair's getting all wet." It was her way of saying "Amen."

On New Year's Day, we were sitting in the sand, just relaxing. Flynt had bought a paperback novel by Gore Vidal in the hotel store, but first he was reading the Sunday *New York Times* and worrying about the implications of juries with only six members. A moment later he was rubbing suntan lotion on my back.

"I'll bet Hugh Hefner never did this for you," he said.

* * *

Larry Flynt had been traveling around a lot, but he happened to be back in L.A. at the same time that my friend LSD guru Ram Dass was visiting, so I had the unique pleasure of introducing them. Larry, Althea,

Ram Dass and I went to a health-food restaurant, where we discovered that we shared something in common: we were all practicing celibacy – Larry at the suggestion of Dick Gregory, Althea by extension, Ram Dass for spiritual purposes, and me just for the sheer perversity of it.

When Larry got shot down south by a racist nut because *Hustler* had a black naked model, Althea had transformed the Coca-Cola Suite at Emory University Hospital into her office, where she was now studying the slides of the irreverent "Jesus and the Adulteress" feature. Dick Gregory was there, and he said, "This scares *me*." He was concerned about reaction in the Bible Belt, notwithstanding the fact that *Hustler's* research department had already made certain that the text followed the Bible.

And now Althea was checking for any sexism that might have slipped past the male editors' limited consciousness. The spread was already in page forms, but not yet collated into the magazine, and there was still a gnawing dilemma about whether or not to publish it.

The marketing people were aghast at the possibility that wholesalers would refuse to distribute an issue of the magazine with such a blatantly blasphemous feature. Althea and I voted to publish. Gregory and editor Bruce David voted not to publish. "I'm against it," he said, "because we're this is an issue that just simply will not be distributed."

Faced with this crucial decision, Althea made her choice on the basis of pure whimsicality. She noticed a pair of pigeons on the window ledge. One of them was waddling toward the other. "All right," she said, "if that dove walks over and pecks the *other* dove, then we *will* publish this." The pigeon continued strutting along the window ledge, but it stopped short and didn't peck the other pigeon, so publication of "Jesus and the Adulteress" was postponed indefinitely.

Of course, Dick Gregory continued to spread his diligent activism until he died. He was a loss to me, and to this country, and around the world, but his powerful inspiration remains.

The Missing Episode of *Seinfeld*

[Jerry Seinfeld is onstage at a comedy club.]

Jerry: Did God look down at Adam and Eve one day and say, "Oops, I forgot something. Let there be erections." So Adam got the first hard-on in history. But God forgot to say *when.* And that's why men don't always get an erection when they *want* one. Women don't know it, but sometimes men have to actually *pray* for a hard-on. "Please, God, I'll be sensitive to her needs, I promise, oh God, please, just make it hard . . ."

[Cut to George Costanza, having dinner with his parents. There is no conversation, but George's father is smiling, then chortles out loud.]

George: What! What! What's so funny? Is it because I'm becoming more like *you* every day?

George's father: Should I tell 'im? I'm gonna tell 'im.

George's mother: No, don't tell 'im. It's private between you and me. It's none of his beeswax.

George: C'mon, stop teasing me, I wanna know, whatever it is, I wanna know, so c'mon, tell me.

George's father: Okay, I'm gonna tell 'im. I've been taking Viagra, George, and it really works. Your mother and I have been making whoopee like it was going out of style.

George's mother: Yeah, but it's not *me* he gets excited over. It's only because of the Viagra.

George's father: What *difference* does it make, George? Listen to this. The pills cost $10 each, but a friend of mine goes to Mexico and he gets me a whole bottle of fifty for $42.

George: Gee, that's less than a buck a fuck, isn't it?

George's mother: George! You must never say the F-word in this kitchen! *[To her husband]* See, I told you, we never should've told 'im.

[Cut to Jerry's apartment. Kramer bursts through the door.]

Kramer: Jerry! Jerry! I'm gonna be rich! I bought a bunch of shares in Pfizer when it was real low, and now they put Viagra on the market and all the doctors are getting writers' cramp from writing prescriptions, and the stock is going up and up like it swallowed Viagra! Jerry, I'm gonna be able to retire!

Jerry: Retire from *what*? Kramer, you don't do anything *now.*

Kramer: Yes, I do. I scheme. I spend a lot of time scheming, Jerry. But now I'll be able to *finance* my schemes. I'm gonna be able to call my own bluff, every day! If that's not retirement, I don't know what is.

Jerry: Anyway, I might get this Stand-up Comedy Award tonight, and I' m trying to think of what to say that will sound completely spontaneous. So, Kramer, what' s your *current* scheme?

Kramer: Okay, I got this idea because of the insurance companies. Blue Cross will pay for six Viagra pills a month. Well, that' s very arbitrary, isn' t it? I mean I get six hard-ons in one *day.*

Jerry: That' s the national average, you know, six hard-ons a day.

Kramer: Jerry, believe me, Kramer don' t have "average" hard-ons. But here' s my merchandising plan. It' s for one-night stands—a combination package of Viagra and RU486, the morning-after pill. It' s a natural for the unisex market.

[Cut to the restaurant. Elaine and George are sitting at the table.]

Elaine: But, George, that' s stealing.

George: Yep. And from my own parents.

Elaine: You have no scruples. How do you know your father isn' t *counting* the number of times he "makes whoopee" with your mother? He' ll *realize* that you took some of his Viagra pills when he thinks he has nine more times to go but the bottle has only five pills left?

George: You think he keeps a tally sheet? He' ll never even suspect.

Elaine You're in denial again—but you have to give me a couple of pills. I would just *love* to put a Viagra into Jerry and Kramer's coffee.

George: Oh, really? I thought you had *scruples,* Elaine. Dosing somebody is unethical, especially friends.

Elaine: Oh, didn't I tell you? I had my scruples removed with laser surgery.

George: Seriously, Elaine, what about all the *side effects* of Viagra?

Elaine: Stop worrying, George. Hurry, let me just have two. Jerry and Kramer will be here any minute.

[Cut to the Stand-up Comedy Award ceremonies. Jerry, Elaine, George and Kramer have been sitting at a table, drinking coffee. Suddenly the table rises slightly.]

Jerry: Kramer, stop that, what are you *doing?*

George: Maybe he's holding a one-man séance.

Kramer: I can't get it *down!* Jerry, I can't get it *down!*

Elaine: Gosh, Kramer, you must have been thinking about sex, huh?

Kramer: No, I was thinking about my business plan. That's the only thing that really arouses me. When I'm with a babe, I just think about my latest scheme and I get aroused. But I always let the babe take the credit.

[Courtney Cox is emceeing the event. Now she's announcing the winner.]

Courtney: And the Best Stand-up Comedy Award goes to . . . Jerry Seinfeld!

[Jerry walks up to the stage. Courtney and Jerry embrace warmly. She gives him the statuette. As the audience applause subsides, the blood flow to the spongy tissue in Jerry's penis increases. He tries unsuccessfully to hide his erection with the statuette.]

Jerry: Thank you all so much. Well, as you can *see*, I'm very excited about receiving this reward. I feel all tingly. And I have a headache. I'm a little dizzy too. An erection is like a cop. When you *want* one, it's never there. But when the *last* thing in the world you want is a hard-on—a *public* hard-on—then *boing!* I'm busted, right here on stage, with a spotlight, in front of five hundred strangers. I feel like I have to vomit. I'll try to avoid the first few rows. And everything looks blue. Especially my testicles. Is there a groupie in the house? Well, I'm not actually a *group*. Is there a *singly* in the house? Who would like to get laid tonight? I'll point the way. So I've become a human dowsing rod. Now I think I'm gonna faint. But even while I'm lying unconscious here on the stage *[Jerry is fainting]*, my penis will still be a stand-up . . .

THE LATER YEARS

Are Rape Jokes Funny?

Abortion was still illegal in 1970. At the time, as both an underground abortion referral service and a stand-up satirist, I faced an undefined paradox. I wouldn't allow victims to become the target of my humor, yet there was one particular routine I did that called for a "rape-in" of legislators' wives in order to impregnate them so that they would then convince their husbands to decriminalize abortion..

But feminist friends objected. I resisted at first, because it was such a well-intentioned joke. And then I reconsidered. Even in a joke, why should women be assaulted because men made the laws? Legislators' wives were the victims in that joke, but the legislators themselves were the oppressors, and their hypocrisy was really my target. But for me to stop doing that bit of comedy wasn't chickenshit censorship, it was empathetic editing.

Now, more than four decades later, rape-joking triggered a widespread controversy when a woman who prefers to remain anonymous went to a comedy club, expecting to be entertained. She chose the Laugh Factory in Hollywood because Dane Cook was on the bill, but he was followed by Daniel Tosh, and she had never heard of him.

In an email to her *Tumblr* blogger friend, she accused Tosh of saying that "rape jokes are always funny, how can a rape joke not be funny, rape jokes are hilarious." She was so offended that she felt morally compelled to shout, "Actually, rape jokes are *never* funny!" Tosh paused and then seized the opportunity, responding, "Wouldn't it be funny if that girl got raped by like five guys? Like right now? What if a bunch of guys just raped her?" The audience laughed raucously. After all, isn't anyone who yells at a comedian practically asking to become an immediate target? But this woman was stunned and humiliated, and she left. In the lobby, she demanded to see the manager, who apologized profusely and gave her free tickets for another night--admitting, however, that she understood if this woman never wanted to return.

In her email, she concluded that, "having to basically flee while Tosh was enthusing about how hilarious it would be if I was gang-raped in that small, claustrophobic room was pretty viscerally terrifying and threatening all the same, even if the actual scenario was unlikely to take place. The suggestion of it is violent enough and was meant to put me in

my place." She added, "Please re-blog and spread the word." And indeed, it went viral.

Coincidentally, on the same night that Tosh, in his signature sarcastic approach to reality, provoked the woman, Sarah Silverman was performing at Foxwords Casino, and she touched upon the same taboo subject: "We need more rape jokes. We really do. Needless to say, rape, the most heinous crime imaginable, seems it's a comic's dream, though. It's because it seems when you do rape jokes, that the material is so dangerous and edgy, and the truth is, it's like the safest area to talk about in comedy 'cause who's gonna complain about a rape joke? Rape victims? They don't even *report* rape. They're just traditionally not complainers."

Ironically, in *The Aristocrats*, a documentary entirely about a classic joke of the same name, Silverman complained (facetiously) that she was once raped by show-biz legend Joe Franklin. Also, her rape tips for men include, "Carry a rape whistle. If you find that you are about to rape someone, blow the whistle until someone comes to stop you." However, another joke of hers goes like this: "I was raped by a doctor—which is so bittersweet for a Jewish girl."

In the magazine *Bitch (* "Feminist Response to Pop Culture"), an article titled "Laughing It Off: What Happens When Women Tell Rape Jokes?" by Katherine Leyton stated: "Some female comics tell jokes that clearly target rape culture, such as one classic skit by veteran comedian Wanda Sykes, 'Even as little girls we're taught we have something everybody wants—you gotta protect it, you gotta be careful, you gotta cherish it. That's a lot of fucking pressure! I would like a break! You know what would make my life so much easier? Wouldn't it be wonderful if our *pussies were detachable?'* The joke goes on to detail situations where you could leave your 'detachable pussy' at home, mainly to avoid the chance of rape."

* * *

In the fall of 1981, I booked myself for a cross-country tour, from New York to Chicago, Minneapolis, San Francisco and Los Angeles.

While I was in New York, a nun was raped. When I got to Chicago, the rapist was also there. He had given himself up to the police. On stage I explained the true reason why: "He heard that the Mafia, in a rush of Christian compassion, put a $25,000 contract out on his life." That part was true. "So now I'm asking the Mafia to use their clout to end the war in El Salvador since *four* nuns were raped and killed there." They

must' ve heard my request. By the time I got to Los Angeles, the *Herald-Examiner* was reporting that the Mafia was "probably the largest source of arms for the rebels in El Salvador."

In the spring of 1982, there was a Radical Humor Festival at New York University. That weekend, the festival sponsored an evening of radical comedy. The next day, my performance was analyzed by an unofficial women's caucus. Robin Tyler ("I am not a lesbian comic--I am a comic who is a lesbian") served as the spokesperson for their conclusions. What had caused a stir was my reference to the use of turkey basters by single mothers-to-be who were attempting to impregnate themselves by artificial insemination. Tyler explained to me, "You have to understand, some women still have a hang-up about penetration."

Well, I must have been suffering from Delayed Punchline Syndrome, because it wasn't until I was returning on a plane, contemplating the notion that freedom of absurdity transcends gender difference, that I finally did respond, in absentia: "Yeah, but *you* have to understand, some men still feel threatened by turkey basters."

* * *

The Onion posted a story about a college dorm that was nicknamed "The Rape Hall." And an *Ironic Times* headline stated, "Quaaludes Ends

Its Relationship With Bill Cosby." Earlier in Amy Schumer's stand-up career, she told this joke: "I used to date Hispanic guys, but now I prefer consensual." She has since been accused of racist comedy. "I used to do a lot of short dumb joke like that," she responded." I played a dumb white girl onstage. I am evolving as an artist. I am taking responsibility and hope I haven't hurt anyone. I apologize if I did."

Indeed, in an episode of *Inside Amy Schumer* on Comedy Central, a sketch--*Football Town Nights* parodying *Friday Night Lights*--featured a Texas town's new high school football coach. He informs his teenage squad that he's going to be doing things differently. There's going to be a no-huddle offense. Two-a-day practices are mandatory. And there will be no raping. "But we play football!," one player cries. The rest of the team chimes in: "But we play football!" "What if she thinks it's rape, but I don't?" "What about at-away games?" "What if my mom is the DA and won't prosecute, can I rape?" The whole town bullies this coach for taking something away from the players that they obviously need.

In another sketch, Schumer plays a flirtatious lawyer ironically *defending* Cosby by bedazzling the judge as well as the jury. In a one-woman show about rape, *Asking For It,* responding to Daniel Tosh, award-winning British comic Adrienne Truscott performs with her bare vagina

uncovering a photo of Bill Cosby. And on *Late Night,* Seth Myers rhetorically asks, "Why did Bill Cosby cross the road?" He answers himself, "To avoid a reporter who was asking about sexual assault allegations."

At the National Association of Television Program Executives conference, Jay Leno commented on the allegations against Bill Cosby: "I don't know why it's so hard to believe women. You to go Saudi Arabia and you need two women to testify against a man. Here you need twenty-five [now forty-five]." Leno also used one of Justin Bieber's song hits for a punchline, pointing out that Bieber "wouldn't want to sing 'I Wanna Be Your 'Boyfriend'' to guys in prison."

In a routine about political correctness, George Carlin suggested that a euphemism for a rape victim would be "unwilling sperm recipient." On *The View,* Joy Behar exclaimed that she would vote for a rapist as long as he supported beloved feminist issues like abortion and the free contraception they bicker so much about.

On *The Daily Show,* Jon Stewart aimed his arrow at presidential candidate Donald Trump (who bought 20,000 copies of *The Art of the Deal,* making it a bestseller). Stewart shouts, "There are probably some non-rapists caught up in that tide, whether they're unable to rape for medical reasons, or whether they're just all raped-out." A clip shows

Trump reading out loud from a report that "80% of Central American women and girls are raped crossing into the United Sates." CNN's Don Lemon tells Trump, "That's about women being raped, it's not about criminals coming across the border or entering the country."

Trump: "*Somebody's* doing the raping, Don."

"*Touche!,*" said Stewart. "I believe we have our campaign slogan: *Trump 2016--Somebody's Doing the Raping*."

Immediately after *The Daily Show* came *The Nightly Show* with Larry Wilmore. He plays the same clip just a slightly bit longer: Trump spouting, "*Somebody's* doing the raping, Don. I mean, you know, somebody's *doing* the rapiing, You think the women are being raped. Well, who's *doing* the raping?" Wilmore repeats: "*Who's doing the raping?* Okay, who's bringing the chips? Who's bringing the beer? *Wait, wait. Who's doing the raping?* Oh, okay, sorry about that. I didn't know, I had to ask. I have to tell you, though, as far as campaign slogans go: *Donald Trump 2016--Who's Doing the Raping?*" Hey, it sounds familiar already.

And on Bill Maher's *Real Time,* the reactionary blond witch Ann Coulter defended Trump: "These aren't people we have to have here. We already have our own rapists and murderers. We don't need to be bringing in more rapists and murderers."

* * *

Although Daniel Tosh is a consistently unapologetic performer for the sardonic material he exudes on his Comedy Central series--which features a running theme of rape jokes, even including one about his sister--for this occasion he decided to go the Twitter route: "All the out of context misquotes aside, I'd like to sincerely apologize." He also tweeted, "The point I was making before I was heckled is there are awful things in the world but you can still make jokes about them."

According to Jamie Masada, owner of the Laugh Factory, Tosh asked the audience, "What you guys wanna talk about?" Someone called out "Rape," and a woman in the audience started screaming, "No, rape is painful, don't talk about it." Then, says Masada, "Daniel came in, and he said, 'Well, it sounds like she's been raped by five guys'—something like that. I didn't hear properly. It was a comment—it wasn't a joke at the expense of this girl." Masada claims that she sat through the rest of Tosh's performance, which received a standing ovation, before she complained to the manager.

Fellow comedians defended Tosh with their own tweets. Dane Cook: "If you journey through this life easily offended by other peoples words I think it's best for everyone if you just kill yourself." Doug Stanhope:

"You're hilarious. If you ever apologize to a heckler again I will rape you." Louis C.K.: "Your show makes me laugh every time I watch it. And you have pretty eyes" --except that he wrote it after watching Tosh on TV, but before he learned about the Laugh Factory incident. Nevertheless, he was excoriated and accused of being a "rape apologist." But C.K. himself is no stranger to sexual-assault jokes. Onstage, he has said that he's against rape-- "unless you have a reason, like you wanna fuck someone and they won't let you, in which case what other option do you have?"

Conversely, in an episode of his TV series, *Louie*, he reversed such roles. After leaving a bar with an especially aggressive woman, Laurie (played by Melissa Leo), that he had inadvertently met earlier, she performs fellatio on him in her pickup truck, then insists that he in turn perform cunnilingus on her. And he refuses. So, she attacks him physically with unabashed viciousness, mounts him, and he gives in to her demand. In other words, Laurie rapes Louie. No joke. To watch this scene was positively jaw-dropping. It served as a reminder of how often comedians--and their jaded audiences--find prison-rape jokes not only to be funny, but also, as in the case of pedophile Jerry Sandusky, an act of delayed justice resulting in laughter that morphs into applause. A *N.Y. Post* headline about pedophile Subway pitchman: "Enjoy a foot long in jail."

And "Don't drop the soap" even made its way to the animated *Family Guy.*

Meanwhile, reacting to the Tosh tirade, Julie Burton, president of the Women's Media Center, stated: "If free speech permits a comedian to suggest a woman in his audience should be gang-raped, then it certainly permits us to object, and to ask what message this sends to survivors or to perpetuators. Tosh's comment was just one extreme example of pop culture's dismissive treatment of sexualized violence, which desensitizes audiences to enormous human suffering. Internet outcry is encouraging, but popular media needs to push back too."

And the original blogger posted another message:

"My friend and I wanted to thank everyone for there *[sic]* support and for getting this story out there. We just wanted everyone to know what Daniel Tosh had done and if you didn't agree then to stop following him. My friend is surprised to have gotten any form of an apology and doesn't wish to press any further charges against [him]." What? Press charges? Rape is a crime. Rape jokes aren't. They are the risk of free speech. The blog concluded, "She does plan on returning to comedy shows in the future, but to see comedians that she's seen before or to at least look up artists before going to their shows."

Wait till she finds out that Dane Cook suggested she kill herself.

* * *

Now, over forty years since I stopped presenting my concept about a rape-in of legislators' wives, I sent the first draft of this piece around to several friends, and I was particularly touched by a response from Emma Cofod, production manager at my then-publisher, Soft Skull Press:

"Thank you for sharing this! I truly appreciate your thoughts here. I read about this woman's complaint last week, and the whole event turned my stomach. What Tosh did was personally threatening, which is not OK. But even though I fall neatly into the feminist camp, I think your original joke is hilarious—within context, and coming from a comedian whose philosophy I identify with. Color me conflicted."

I think that kind of conflict is healthy. And then there was Louis C.K.'s appearance on *The Daily Show*. This is what he told Jon Stewart between interruptions:

"If this [controversy about Tosh] is like a fight between comedians and bloggers--hyperbole and garbage comes out of those two places, just uneducated, unfettered--it's also a fight between comedians and feminists, because they're natural enemies, because, stereotypically speaking, feminists can't take a joke, and on the other side, comedians

can't take criticism. Comedians are big pussies. So to one side you say, 'If you don't like a joke, stay out of the comedy clubs.' To the other side you say, 'If you don't like criticism, stop Googling yourself every ten seconds, because nobody's making you read it.' It's positive. To me, all dialogue is positive. I think you should listen.

"If somebody has the opposite feeling from me, I wanna *hear* it so I can *add* to mine. I don't wanna obliterate theirs with mine, that's how I feel. Now, a lot of people don't feel that way. For me, any joke about anything bad is great, that's how *I* feel. Any joke about rape, a Holocaust, the Mets--*aarrgghh*, whatever--any joke about something bad is a positive thing. But now I've read some blogs during this whole [controversy] that made me enlightened at things I didn't know. This woman said how rape is something that polices women's lives, they have a narrow corridor, they can't go out late, they can't go to certain neighborhoods, they can't dress a certain way, because they might--I never--that's part of me now that wasn't before, and I can still enjoy the rape jokes.

"But this is also about men and women, because a lot of people are trading blogs with each other, couples are fighting about Daniel Tosh and rape jokes--that's what I've been reading in blogs--but they're both making a classic gender mistake, because the women are saying, 'Here's

how I *feel* about this,' but they're also saying, 'My feelings should be everyone's primary concern.' Now the men are making this mistake, they're saying, 'Your feelings don't matter, your feelings are wrong and your feelings are stupid.' If you've ever lived with a woman, you can't step in shit worse than that, than to tell a woman that her feelings don't matter. So, to the men I say, 'Listen to what the women are saying about this.' To the women I say, "Now that we heard you, shut the fuck up for a minute, and let's all get back together and kill the Jews.' That's all I have to say about it."

The audience laughed and applauded, as they did fifty years ago when Lenny Bruce ended a riff on prejudice: "Randy, it won't matter any more even if you are colored and I'm Jewish, and even if Fritz is Japanese, and Wong is Greek, because then we're all gonna stick together—and beat up the Polacks."

My notion of a rape-in of legislators' wives in order to impregnate them was no more meant to be taken literally than Louis C.K.'s killing the Jews or Lenny's beating up the Polacks. Rape-in was a misunderstood metaphor; a pro-choice parable that unfortunately has become timely again, but now my target has been clarified, though it's still those increasingly incredible sexist legislators.

Words and Phrases That I've Coined

I really don't like to boast, but in my lifetime, on half a dozen occasions, I have actually added words and phrases to the language. It's something I always wanted to do. What a thrill it must have been for Dr. Harold Cerumen, who decided that cleaning out earwax should be known as "cerumen disimpaction." And veterinarian Alice Neuticle who coined the word "neuticles"—cosmetic testicles for a dog that's been neutered.

So I'm not asking for credit. Or cash. Since money had been called "dough" and then morphed into "bread," I figured that "toast" would be the next logical step in that particular linguistic evolution, but my campaign itself became toast, in the sense that "toast" now means history.

Also, I was intrigued by the process of having a body part named after oneself. How proud Casper Bartholin's parents must have been to have a son who christened the source of female lubrication that takes the friction out of intercourse as "Bartholin's glands." But my idea of calling those two vertical lines between your nose and your mouth "Krassner's crease" just never became popular.

Here, then, for better or worse, are my contributions to American culture that did manage to catch on, or at least may be on their way.

1. In 1958, pornography was gradually becoming legal, but at that stage of the game, the Supreme Court was unwilling to allow 1st Amendment protection of "hard-core" porn—as opposed, I assumed, to the term I invented, "soft-core porn," which was obviously more respectable, though it seemed kind of sneaky, pretending to be squeaky clean. So I decided to satirize the concept with a new feature in *The Realist:* "Soft-Core Porn of the Month."

For example, phallic symbolism in newspapers and magazines was a key ingredient of soft-core porn. Sample: A close-up of a stickshift in a 1965 Volkswagen ad was accompanied by the question, "Does the stickshift scare your wife?" Soft-core porn now refers to limited sexuality, as seen in network TV dramas and hotel-room movies that feature jiggling breasts and buttocks but no genitalia. The way to recognize soft-core porn is that it gives men a soft-on.

2. On the afternoon of December 31, 1967, several activist friends were gathered at Abbie and Anita Hoffman's Lower East Side apartment, smoking Columbian marijuana and planning a counter-convention for the Democratic Party's event the following summer in Chicago. Our fantasy

was to counter their convention of death with our festival of life. While the Democrats would present politicians giving speeches at the convention center, we would present rock bands playing in the park. There would be booths with information about drugs and alternatives to the draft. Our mere presence would be our statement.

We needed a name, so that reporters could have a *who* for their journalistic who-what-when-where-and-why lead paragraphs. I felt a brainstorm coming on and went from the living room to the bedroom so that I could concentrate. Our working title was the International Youth Festival. But the initials IYF were a meaningless acronym. I paced back and forth, juggling titles to see if I could come up with words whose initials would make a good acronym. I tried Youth International Festival. YIF. It sounded like KIF. Kids International Festival? Nope, too contrived. Back to YIF. But what could make YIP? Now that would be ideal because then the word Yippie could be derived organically.

Of course, "Yippie" was already a traditional shout of spontaneous joy, but we could be the Yippies! It had exactly the right attitude. Yippies was the most appropriate name to signify the radicalization of hippies. What a perfect media myth that would be—the Yippies! And then, working backward, it hit me. Youth International Party! It was a natural. *Youth:* This

was essentially a movement of young people involved in a generational struggle. *International:* It was happening all over the globe, from Mexico to France, from Germany to Japan. And *Party:* In both senses of the word. We would *be* a party and we would *have* a party.

Yippie was only a label to describe a phenomenon that already existed--an organic coalition of psychedelic dropouts and political activists. There was no separation between our culture and our politics. In the process of cross-pollination, we had come to share an awareness that there was a linear connection between putting kids in prison for smoking marijuana in this country and burning them to death with napalm on the other side of the planet. It was just the ultimate extension of dehumanization. But now reporters had a *who* for their lead paragraphs. A headline in the *Chicago Daily News* summed it up: "Yipes! The Yippies Are Coming!" Our myth was becoming a reality.

3. In 1972, I found myself smoking a combination of marijuana and opium with John Lennon and Yoko Ono. Lennon was absentmindedly holding on to the joint, and I asked him, "Do the British use that expression, 'Don't bogart that joint,' or is it only an American term--you know, derived from the image of a cigarette dangling from Humphrey Bogart's lip?" He replied, with a twinkle in his eye, "In England, if you

remind somebody else to pass a joint, you lose your own turn." Since Bogart and Lauren Bacall were a classic Hollywood couple, I was inspired by that snippet of dialogue to say, "Don't *bacall* that joint."

4. Intuitively, I was an advocate of equal rights and opportunities for both genders long before Women's Liberation became a movement. In 1959, I wrote, "From a completely idealistic viewpoint, classified ads for jobs should not have separate Male and Female classifications, with exceptions such as a wet-nurse." In 1964, that practice became illegal. Masturbation was a powerful taboo for females, a subdivision of the war on pleasure, while it was somehow expected of males. But if it was okay for guys to jack-off, I wrote in a media fable, *Tales of Tongue Fu,* in 1974, then it was also okay for girls to jill-off.

5. In 1979, I covered for a weekly alternative paper the trial of ex-cop Dan White for the double execution of San Francisco Mayor George Moscone and Supervisor Harvey Milk, the gay equivalent of Martin Luther King. In a surprise move, homophobic White's defense team presented a bio-chemical explanation of his behavior, blaming it on compulsive gobbling down of sugar-filled junk-food snacks. This was a purely accidental tactic. Dale Metcalf, an attorney, told me how he happened to be playing chess with one of White's attorneys, Steven Scherr.

Metcalf had just read *Orthomolecular Nutrition* by Abram Hoffer. He questioned Scherr about White's diet and learned that, while under stress, White would consume candy bars and soft drinks. Metcalf recommended the book to Scherr, suggesting the author as an expert witness. In his book, Hoffer revealed a personal vendetta against doughnuts, and White had once eaten five doughnuts in a row.

During the trial, psychiatrist Martin Blinder testified that, on the night before the murders, while White was "getting depressed about the fact he would not be reappointed [as supervisor, after having quit], he just sat there in front of the TV set, bingeing on Twinkies." In my notebook, I scribbled "Twinkie defense," and wrote about it in my next report.

In the wake of the Twinkie defense, a representative of the Continental Baking Company asserted that the notion that overdosing on the cream-filled goodies could lead to murderous behavior was "poppycock" and "crap"—apparently two of the artificial ingredients in Twinkies, along with sodium pyrophosphate and yellow dye—while another spokesperson couldn't believe "that a rational jury paid serious attention to that issue." Nevertheless, some jurors did. One remarked after the trial that "It sounded like Dan White had hypoglycemia."

Later, the *San Francisco Chronicle* reported: "During the trial, no

one but well-known satirist Paul Krassner—who may have coined the phrase 'Twinkie defense'—played up that angle. His trial stories appeared in the *San Francisco Bay Guardian."*

6. Twitter is an interesting phenomenon. It's perfect for those folks with a short attention span, and it's scary for paranoids who don't want to be followed. It appeals to minimalists, such as, say, Bob Dylan. I once asked him, "How come you're taking Hebrew lessons?" He replied, "I can't speak it." And when I mentioned the Holocaust, he responded, "I resented it."

Tweets range from the trivial (David Gregory announcing that he was going to eat a bagel before moderating *Meet the Press*) to international conflicts (Iranian citizens reporting on the uprising against their repressive government). It occurred to me that there could be classic haiku tweets—three lines consisting of 5 syllables, 7 syllables and 5 syllables—adding up obviously to no more than 140 characters—and so I decided to embed the phrase I coined in the following (also) twaiku:

What's worth sharing now?

World War Three or stubbed my toe?

I have Twitter's Block.

My Brother’s Secret Space Communication Projects

When my brother George and I were kids, I could recite the alphabet backwards, whereas he read the entire dictionary. We both played the violin, and when he was nine and I was six, we performed at Carnegie Hall. (I was the youngest concert artist in any field to perform there.) Our younger sister Marge took piano lessons and became a legendary figure at Boys and Girls High School in Brooklyn, teaching music and running the chorus. Now retired, she and two women--one plays the cello, the other a flute—recently performed at the Salvador Dali Museum in St. Petersburg, Florida, playing music connected to various phases of Dali’s life. (She also teaches Tai Chi.)

Marge was the only one in our family who stuck with classical music. Although I was considered a child prodigy, I merely had a technique for playing the violin, but I had a real *passion* for making people laugh. I put my violin in the closet when I was twelve, and several years later I used it essentially as a prop when I began performing stand-up comedy. George went to the High School of Music & Art, and was offered a four-year scholarship at the Juilliard School’s renowned Music Division, but he

really preferred Math and Science. He surprised our parents, announcing his decision to be an electrical engineer, but they were supportive.

He turned down the scholarship and instead attended CCNY. "Because," he says, "I thought then that the violin was good for my avocation, not my vocation. With so many brilliant musicians then, you really had to know somebody to get anywhere in that world. It's not like YouTube today." While at CCNY, he played with a square dance group and became Official Fiddler for the New York/New Jersey Square Dance Callers Association. He learned that a caller earned twice as much as he did, so he put down his fiddle and took up calling square dances. He was also captain of the varsity boxing team.

George went to the University of Michigan for his Master's Degree. Our mother insisted--and to please her--he mailed his laundry home in a light aluminum case she had purchased for that specific purpose. To pay for his tuition, basement apartment and other expenses, he got a teaching fellowship, was a research assistant, sold programs at football games, and bussed tables at a local restaurant, which he quit when the table he cleared was occupied by fellow students.

He won the all-campus boxing championship, but had to fight in a heavier weight class since no one else weighed as little as he did. "Being a

violinist," he said, "I was worried about my hands. But my opponent in the semi-final match was an oboe player with a concert scheduled for the next day, and he asked me to take it easy on his mouth."

* * *

In October 1957, Russia sent Sputnik into space. It was the first orbiting satellite, circling the earth in 96 minutes, and making 1,440 orbits in three months. This astounding technical feat was totally unanticipated by the United States and ignited the era of the space race. At the time, George was working as a civilian scientist for the Army Signal Corps in Fort Monmouth, New Jersey, in charge of the radio relay program. He had been recruited by their senior executive of Research & Development, an alumnus of the University of Michigan.

A week after Sputnik, George sent a proposal to the Commanding General, urging a space communication program. The response: *Do it!* "So," George recalls, "I created the first Space Electronics organization in the country. It was very strange making presentations to generals and top government officials. At age twenty-nine, as head of the Astro-Electronics Division, I had the civilian rank equal to a colonel, but I looked like a young kid. It was embarrassing to take them to lunch and be carded by the waiter."

That wasn't his only embarrassment: "At the Signal Corps, I accidentally flushed my top secret badge down the toilet. It took a lot of official paperwork and the notation 'irretrievably lost' to finally get a new badge. Also, in 1954, the McCarthy paranoia was paramount. I, and fellow civilians--and military personnel, I assume--had to empty our lunchboxes and briefcases for inspection every time we entered the building."

Five months after he had begun as a civilian scientist, George was drafted. In the army, he was assigned to the 82nd Airborne Division at Fort Bragg in North Carolina. He was a "leg," though. Instead of jumping out of an airplane, his job was to maintain all radios, phones and electrical equipment. He also started the U.S. Helicopter Square Dance Team to demonstrate the mobility of helicopters. When assigned KP (Kitchen Police), rather than peel potatoes, he scheduled helicopter square dance practice.

Eight months after Sputnik, his team began working on the design of the world's first communication satellite, SCORE (Signal Communications Orbit Relay Equipment). "There were no reference books, precedents, or Google for information. We were the pioneers. It's

interesting that the first known reference to communication satellites was in a 1945 science-fiction story by the British author, Arthur C. Clarke."

It took the team only six months to design and build the satellite, which was launched in December 1958 by an Atlas rocket that weighed 9,000 pounds. "The satellite payload became famous for the tape-recorded message from President Dwight Eisenhower, who insisted that this project remain top secret," George tells me. "He said the launch would be aborted if any word leaked out, because he didn't want a chance of failure to tarnish our image. As it turned out, one of the two tape recorders did fail, but his Christmas message to the world was the very first transmitted message from space."

Eisenhower stated: "This is the president of the United States speaking. Through the marvels of scientific advance, my voice is coming to you via a satellite circling in outer space. My message is a simple one. Through this unique means, I convey to you and all mankind America's wish for peace on earth and good will toward men everywhere."

* * *

In 1945, in the wake of World War II, the victors launched Operation Paperclip, recruiting a variety of six hundred scientists from Nazi Germany to work in the United States. President Harry Truman ordered the

exclusion of any "member of the Nazi Party or an active supporter of Nazi militarism," but the Joint Intelligence Objectives Agency created false employment and political biographies to circumvent Truman's command.

Those scientists were then granted security clearance and infiltrated into hospitals, universities, and the aerospace industry, further developing their techniques in propaganda, mind control, and behavior modification. Among them was Wernher von Braun, who had been a member of the Nazi Party and an SS officer who could be linked to the deaths of thousands of concentration camp prisoners. (Fun fact: He married his cousin.) He came to America in 1945 and became a citizen in 1955. He was called the "Father of the U.S. space program."

In June 1958, by the time those German importees had become entrenched in a slew of American niche communities, I published the first issue of *The Realist*, including a cartoon that depicted the U.S. Army Guided Missile Research Center with a sign in the window, *Help Wanted*. A couple of scientists are standing in front of that building, and one is saying to the other, "They would have hired me only I don't speak German."

Exactly one year later, Wernher von Braun recruited thirteen scientists to work with him on an ultra-top-secret program, Project Horizon, to build a communication station on the moon. Its purpose was a

study to determine the feasibility of constructing a scientific/military base. "I was one of the lucky thirteen," George remembers. "In fact, you don't have to be a rocket scientist to be a rocket scientist. Von Braun told me that many of his ideas came from science-fiction magazines.

"The project was so secret that the thirteen of us could not even tell our bosses--they didn't have what was called 'need to know.' I would tell [my wife] Judith that I was going to Washington, D.C., and then I would change planes to go to Huntsville, Alabama, where much of the work was done. I made up stories about Washington for her, while I really was in Huntsville, which also was the watercress capital of the world. I'd make up a story about the cherry blossoms, or seeing a senator in the street.

"Unfortunately, when I left the government after nine years (two in the army), I lost my own security rating and need-to-know, so I had no idea if the station was ever built on the moon, and I no longer got cheap watercress." According to Wikipedia, "The permanent outpost was predicted to cost $6 billion and become operational in December 1966. A lunar landing-and-return vehicle would have shuttled up to 16 astronauts at a time to the base and back. Horizon never progressed past the feasibility stage in an official capacity."

However, just like George had lied to Judith, he in turn learned in 2014 that he was lied to about the *actual* purpose of Project Horizon: "[It] was a study to determine the feasibility of constructing a science/military based on the Moon. On June 8, 1959, a group of the Army Ballistic Missile Agency (ABMA) produced for the U.S. Department of the Army a report entitled *Project Horizon, a U.S. Army Study for the Establishment of a Lunar Military Outpost.*

"The project proposal states the requirements as: The lunar outpost is required to develop and protect potential United States interests on the moon; to develop techniques in moon-based surveillance of the earth and space, in communications relay, and in operations on the surface of the moon; to serve on a base for exploration of the moon, for further exploration into space and for military operations on the moon if required; and to support scientific investigations on the moon."

* * *

"When I had been in the Army, I was assigned to work on top secret military and satellite work," George tells me, "the FBI did routine checks. One of our neighbors told Judith that the FBI visited them but were told not to let us know of their inquiries. Apparently, you were on their 'watch list' --based on your 'radical' writings, I assume. I learned

from my boss at the Signal Corps that my top-secret clearance was in jeopardy. Granting my clearance took about a month longer than normal, but eventually it was granted."

Meanwhile, I was placed on the FBI's RI (Round-up Index), though I had broken no law. Who knows, maybe it was because I published a cartoon depicting a man sitting at a desk, speaking on the phone: "I'm very sorry, but we of the FBI are powerless to act in a case of oral-genital intimacy unless it has in some way obstructed interstate commerce."

When *Life* magazine ran a favorable profile of me in 1968, an FBI agent sent a poison-pen letter to the editor: "To classify Krassner as some sort of 'social rebel' is far too cute. He's a nut, a raving, unconfined nut." But in 1969, the FBI's previous attempt at mere character assassination escalated to a more literal approach. This was not included in my own Co-Intel-Pro (Counter-Intelligence Program) files but, rather, a separate FBI project calculated to cause rifts between the black and Jewish communities.

The FBI had produced a WANTED poster featuring a large swastika. In the four square spaces of the swastika were photos of Yippie founders Abbie Hoffman, Jerry Rubin and me, and SDS (Students for a Democratic

Society) leader Mark Rudd. Underneath the swastika was this headline--LAMPSHADES! LAMPSHADES! LAMPSHADES!--and this message:

"The only solution to Negro problems in America would be the elimination of the Jews. May we suggest the following order of elimination? (After all, we've been this way before.) *All Jews connected with the Establishment. *All Jews connected with Jews connected with the Establishment. *All Jews connected with those immediately above. *All Jews except those in the Movement. *All Jews in the Movement except those who dye their skins black. *All Jews. Look out, Abbie, Jerry, Paul and Mark!" (Shades of Wernher von Braun.)

It was approved by FBI director J. Edgar Hoover's top two aides: "Authority is granted to prepare and distribute on an anonymous basis to selected individuals and organizations in the New Left the leaflet submitted. Assure that all necessary precautions are taken to protect the Bureau as the source of these leaflets. This leaflet suggests facetiously the elimination of these leaders." And, of course, if a black militant obtained that flyer and eliminated one of those "New Left leaders who are Jewish," the FBI's bureaucratic ass would be covered: "We *said* it was a facetious suggestion, didn't we?"

On top of that, my name was on a list of sixty-five "radical" campus speakers, released by the House Internal Security Committee. The blacklist was published in the *New York Times*, and picked up by newspapers across the country. It might have been a coincidence, but my campus speaking engagements stopped abruptly.

When I was assigned to write a piece for the *Los Angeles Times*, I titled it "I Was a Comedian for the FBI," because I mentioned that I had once recognized a pair of FBI agents taking notes while I was performing at the Community Church in New York. My FBI files later stated that I "purported to be humorous about the government." Since when did taxpayers provide the funds to cover the FBI's theater critics squad?

The banner headline on the cover of that *L.A. Times Sunday Calendar* section blared out: ***Paul Krassner-- "I Was a Communist for the FBI!."*** In the *San Francisco Chronicle,* columnist Herb Caen wrote, "Fearing Krassner would sue, the *Times* recalled and destroyed some 300,000 copies at a cost of about $100,000. Krassner would have laughed, not sued." Or maybe I would've sued *and* laughed my ass off.

* * *

By 1963, George had risen to Chief Scientist, Astro-Electronics Division at the Signal Corps, and McGraw-Hill contacted him, asking if he would write a book. And indeed, he began working on *Introduction to Space Communication*, which became the world's first book on that subject.

"The problem was the incredible pace of technology," he says. "While I was writing Chapter 5, the nuggets of wisdom in Chapter 2 were becoming obsolete. The last chapter was called 'Ad Astra' (Latin for 'to the stars'), where I tried to forecast future technology. When the book was published in 1964, most of my future projections were already obsolete. Darwin had no idea about the speed of evolution when applied to technology. By the way, more copies of the book were sold in Russia than in the United States."

On George's last active project, he worked with the original seven astronauts. He was program manager at Simmonds Precision, responsible for the design of the fuel gauging system on the command module where the astronauts were housed. In 1972, Apollo 17, the eleventh manned mission, was the sixth and final lunar landing in the Apollo program. "We were on an extremely tight schedule, and my team worked nearly eighty

hours with virtually no sleep to finish on time. We received a rare commendation and bonus from NASA for superior performance ahead of schedule and below budget."

Gordon Cooper--one of those seven original astronauts—had piloted the longest and final Mercury space flight in 1963, becoming the first American to sleep in orbit. "He gave me a rare souvenir," George reminds me, "a dehydrated oatmeal cookie the size of a large dice that he had on a space mission. During a family dinner, I passed around the cookie for everyone to see. Dad was hard of hearing and didn't hear the story, so he popped the space cookie into his mouth, and it was gone before I could get any words out of my mouth. It was pure grief when it happened, but funny now."

As I write this in 2014, George is 85, and if a movie were to be made about him, he'd like to be portrayed by Matt Damon. In October 1988, he was diagnosed with advanced prostate cancer and given three years to live, but his daughter Devra, a naturopath, convinced him to meet with a macrobiotic counselor, and overnight he changed his diet and lifestyle. Now it's twenty-six years later.

He played tennis until six months ago, when he discontinued after a bad fall, because he was playing too aggressively. Currently, his exercise consists of taking walks and lifting dumbbells, though not simultaneously. He remains active, doing business seminars for adult education, providing legal plans for families, small businesses and employees, and calling square dances. But not for helicopters. Or drones.

The Six Dumbest Decisions of My Life

I' m talking here about seriously dumb decisions, not those minor regrets like that time in 1970 when *Esquire* magazine assigned me to fly to New Mexico where director Monte Hellman was filming *Two-Lane Blacktop,* about street-racing. Among the actors was a pair of musicians, James Taylor as a driver, and Dennis Wilson as a mechanic. They both agreed to be interviewed, besides screenwriter Rudy Wurlitzer and others.

During a conversation with Taylor about not laughing at jokes, he said, "My brother once told me a joke that made me laugh."

"Wait, don' t tell me now," I said. "Let' s save it for the interview."

However, I was supposed to reveal behind the scenes of making the movie, but I learned that there were a couple of violations of law: A few members of the cast had been tripping on magic mushrooms; and a 17-year-old actress, Laurie Bird, who played "The Girl," had sex with two members of the crew. Nine years later she would commit suicide.

Anyway, I decided not to write the article--I was a reporter, not a snitch–-and never did get a chance to do any interviews. Nor did I ever hear the joke that James Taylor' s brother told him and made him laugh. I

was mildly disappointed, but what follows are half a dozen of my really dangerous dumb decisions that continue to make me humble.

1. Early one morning in 1963, at my tiny apartment on the Lower East Side of New York (now the East Village), I was in bed with a young woman I had met at a party, when the phone rang. It was her boyfriend, a lower-echelon Mafioso. He asked if I knew where she was. I told him no, even as she was cuddling next to me. He said he would check his source and call me right back. A few minutes later, he did.

"You were seen with her last night. You spent the night with her. She didn't come home last night. You *punk!*"

He said that he was coming to my office a few blocks away—which is where he thought he was calling me—to talk about it. I told her she'd better leave, and I rushed to the office, but he was already waiting outside the "Mad building" [where *MAD* magazine was published], peering through the locked outside door into the lobby, expecting the elevator door to open and me to step out and open the door for him. Instead he saw me on the sidewalk coming toward him.

"What are you doing out here?" he said.

"Well, I came out just a minute ago, but you weren't here."

"I was calling you up because you didn't come out."

"Oh--I figured you had the address wrong, so I took a walk around the block."

"Let's go to your apartment."

"Don't you want to come up to my office?"

"I said. 'Let's go to your apartment.' "

"You don't expect to find her *there?*"

"She leaves traces wherever she goes. By the way, do you have a telephone at your apartment?"

"Oh, yeah, well, it happens to be the same number as my office, incidentally."

There was a certain tension between us while we were walking to my apartment.

"Tell me," he said, "do you have many friends who smoke Tareyton cigarettes?"

I suddenly realized what he meant by "She leaves traces." At the apartment, she was gone, but the bed was unmade and he couldn't help but notice the semen stain on the sheet. Which, of course, was no proof that it was *she* who had been there. However, the ashtray was filled with Tareyton cigarette butts.

"Do *you* smoke Tareytons?"

"No," I answered, "I don't smoke *any* cigarettes."

"I guess I caught you with your pants down, didn't I?"

He picked up the phone and dialed a number. He was calling her mother. "I found him," he said. "What should I do, throw 'im out the window?" I was scared that he might actually do it. He hung up the phone and I didn't know what to expect. I thought, *How could a realist have gotten himself into such an unrealistic situation?*

We proceeded to have a discussion.

"I got the *horns*," he yelled. "I gotta *do* something! It ain't *manly!*"

"Look, restraint itself can be a form of manliness."

"You know," he said, "I could arrange to have you killed while I was having dinner with your mother and father."

"Well, actually, they're not having too many people over to the house these days."

His low chuckle in response to that wisecrack marked a positive turning point in our conversation. He finally forgave me, and we shook hands. Then he borrowed twenty dollars, which we both knew I would never get back, but it was worth not being thrown out the window. I had

known he was her boyfriend, and so I vowed never to risk sleeping with a gangster' s girlfriend, especially if she smoked cigarettes;

2. In 1979, I covered the trial of Dan White,)who had assassinated two progressive government officials in San Francisco--Mayor George Moscone (in 1975, as a state senator, he authored a bill to decriminalize marijuana) and Supervisor Harvey Milk (a dedicated gay activist)—and yet, after an incompetent prosecution and a shrewd defense, White was sentenced to only seven years.

That evening, I was unwinding at home, smoking a joint and preparing to write my final report for the *Bay Guardian*. My reverie was suddenly interrupted by a phone call from Mike Weiss. We had become friends during the trial, which he had covered for *Time* and *Rolling Stone*. He was calling from a phone booth across the street from City Hall. I could hear crowds screaming and sirens wailing behind his voice.

He had to yell: "There' s a riot going on! You should get here right away!"

Reluctantly, I took a cab. When I arrived at Civic Center, there were a dozen police cars that had been set on fire, which in turn set off their alarms, underscoring the shouts from a mob of 5,000 gay protesters. On

the night that Milk was murdered, they had been among the 30,000 who marched silently to City Hall for a candlelight vigil. Now they were in the middle of a post-verdict riot, utterly furious.

But where were the cops? They were all fuming *inside* City Hall--where their commander had instructed them to stay–-armed prisoners watching helplessly as angry demonstrators broke the glass trying to ram their way through the locked doors.

I spotted Weiss and a student from his magazine-writng class, Marilee Strong. The three of us circulated through the crowd. Standing in the middle of the intersection, *Chronicle* columnist Warren Hinckle was talking with a police official, and he beckoned me to join them. I gathered from their conversation that the cops were about to be released from City Hall. Some were already out. One kept banging his baton on the phone booth where Weiss was calling in his story, and he had to wave his press card before the cop would leave.

I found Marilee and suggested that we get away from the area. As we walked north on Polk Street, the police were beginning to march slowly in formation not too far behind us. But the instant they were out of view from City Hall, they broke ranks and started running toward us, hitting the metal pole of a bus stop with their billy clubs, making loud, scary *clangs*.

"We better run," I told Marilee.

"Why? They're not gonna hit us."

"Yes, they are! Run! Hurry!"

The police had been let out of their cage and they were absolutely enraged. Marilee got away, but I was struck with a nightstick on the outside of my right knee. I fell to the ground. The cop ran off to injure as many other cockroaches in his kitchen as he could. Another cop came charging and he yelled at me, *"Get up! Get up!"*

"I'm trying to!"

He made a threatening gesture with his billy club, and when I tried to protect my head with my arms, he jabbed me viciously on the exposed right side of my ribs. *Oh, God, the pain!* The cops were running amuck now, in an orgy of indiscriminate sadism, swinging their clubs wildly and screaming, *"Get the fuck outa here, you fuckin' faggots, you motherfuckin' cocksuckers!"*

I managed to drag myself along the sidewalk. It felt like an electric cattle prod was stuck between my ribs. Marilee drove me to a hospital emergency ward. X-rays indicated that I had a fractured rib and a punctured lung.

The City of San Francisco was sued for $4.3 million by a man who had been a peaceful observer at the riot following the verdict. He was walking away from the Civic Center area when a cop yelled, *"We're gonna kill all you faggots!"* --and beat him on the head with his nightstick. He was awarded $125,000.

I had wanted to sue the city, but an attorney requested $75 for a filing fee, and I didn't have it. I was too foolish not to borrow it, and I decided to forego the lawsuit. I must've been crazy.

3. In 1985, after living in San Francisco for sixteen years, I moved to a walk street in Venice, a block-and-a-half walk to the beach. I rented a top-floor tiny two-room apartment consisting of a kitchen/office where I could see the ocean and a living-room/bedroom which came with a convertible sofa. The bathroom had a bathtub/shower.

One afternoon, I took a bus to Santa Monica to eat at a little soul-food restaurant in a food court and to see a Woody Allen movie. When I returned home, I walked up the steps to the top floor, and when I opened the door to my "penthouse" apartment, it was filled with smoke. I had stupidly, utterly recklessly, left a candle burning in a glass ashtray on the arm of the sofa. I didn't *forget* to do that. I *chose* to leave it that way.

The ashtray had broken in half from the heat, and the sofa was burning, although asbestos material had prevented it from being on fire in a way that would spread the flames. I ran down the steps and got the fire extinguisher off the wall in the hall, ran back up and sprayed the sofa.

"You should be ashamed of yourself," I said to myself.

I was grateful that only the sofa had been destroyed. Also, my pride in expanded consciousness had disintegrated. I've never quite forgiven myself for having endangered the lives and property of the tenants in the other four apartments. I had ignored the concept of cause and effect. My bad. Immensely.

4. On the morning of April 1st, 1995, I flew to San Francisco. I was scheduled to emcee a benefit for Jack Kerouac's daughter, Jan, who had been on dialysis treatment for the last few years. On that sunny afternoon, I was stoned in Washington Square Park, wearing the *MAD* magazine jacket that my daughter Holly had given me for Christmas. The smiling face of Alfred E. Neuman--stating his renowned philosophy, "What--me worry?" --graced the back of my jacket

I was waiting for the arrival of the annual Saint Stupid Day Parade, led this year by Grand Marshal Ken Kesey in an open-topped convertible.

The event was sponsored by the First Church of the Last Laugh. Their sound equipment was surrounded by yellow plastic tape warning, *" Police Line--Do Not Cross."* Somebody in a clown costume handed me a three-foot section of that tape.

The celebration featured music, comedy and a traditional free brunch, along with such favorite rituals as the Sock Exchange and the Leap of Faith. Kesey was also in town to speak at the benefit, which was held only because Jan happened to be the daughter of a ground-breaking literary celebrity, even though he had abandoned her mother when she was pregnant with Jan.

I said to my friend Julius, who drove me there, "It' s not enough any more just to be a sperm donor."

Jan had met her father only twice. The first time, she was nine. The second time, six years later, he sat there, drinking a fifth of whiskey and watching *The Beverly Hillbillies.* Jan would eventually die of kidney failure at the age of forty-four, never having fulfilled her fantasy of becoming drinking buddies with her father, who died when she was a teenager.

Now, backstage, someone I knew handed me a baggie of what I assumed to be marijuana. I thanked her and put it in my pocket. Ah, yes, one of the perks of the benefit biz. Later, as the final members of the

audience were straggling out of the theater, I was sitting with Julius in his car in the parking area at Fort Mason Center.

He was busy rolling a joint in a cigar-box on the dashboard with the map light on. There was a police car circling around in the distance, but we unwisely ignored it. Suddenly, a moment later, there was a fist knocking heavily on the passenger-side window, and a flashlight shining in my eyes. Shit! Fuck! Caught!

We were ordered outside and, with our arms outstretched against the side of the car, with the face of Alfred E. Neuman smiling at the cop and asking, "What--me worry?" And indeed, the cop was worried. He asked me if I had anything sharp in my pockets.

"Because," he explained, "I'm gonna get very mad if I get stuck," obviously referring to a hypodermic needle.

"No," I said, "there's only a pen in this pocket" --gesturing toward the left with my head-- "and keys in that one."

He found the coiled-up three feet of yellow plastic tape warning "*Police Line--Do Not Cross,*" and said, "Where'd you get this?"

"At the Saint Stupid Day Parade."

"What's it for?"

"To keep people away."

But then he found the baggie. And, to my surprise, it contained magic mushrooms. He examined the contents. Then, reeking with sarcasm, he said, "So you like mushrooms, huh?" Under the circumstances, it was such a ridiculous question that I almost laughed, but I realized that, from his point of view, this was a serious offense.

Julius was given a $50 citation for possession of marijuana, but I was arrested on the spot, handcuffed behind my back, and my Miranda rights were read to me. I stood there, heart pounding fast and mouth terminally dry, trying to keep my balance on the cusp of reality and unreality. Fortunately, attorney Doron Weinberg got me off with a $100 fine and nothing on my permanent record.

But I finally understood what that cop meant when he snarled, "So you like mushrooms, huh?" His question was asked with such archetypal hostility that it kept reverberating inside my head. *So you like mushrooms, huh?* It was not as though I had done anything that might harm another human being. This was simply an authority figure's need to control. But control what? My pleasure? Or was it deeper than that?

What was his *actual* message? Back through eons of ancestors--all the way back to what psychedelic researcher Terence McKenna called "the *un*stoned apes" --this cop was continuing a never-ending attempt

to maintain the status quo. He had unintentionally revealed the true nature of the threat he perceived. What he *really* said to me was, "So you like the evolution of human consciousness, huh?"

"Well, yeah," I thought, "now that you mention it, I do. I mean, when you put it like that--*So you like the evolution of human consciousness, huh?*--sure, I do. I like it a whole lot." Too bad I had remained silent instead of using my instinct and advising Julius, "Let's get the hell out of here."

5. Once, in the men's room at an airport, I couldn't help but notice a man standing at a urinal a urinals away from the one where I was carefully aiming my stream with my left hand onto the round marzipan-like disinfectant. But he was allowing his penis to aim itself, because he happened to be busy using both hands to floss his teeth. It was a monument to multi-tasking.

I'm embarrassed to admit that, rather then flossing, I would use a dollar bill to clean between my teeth. Instead, I was actually *adding* bacteria to my mouth, thereby giving a new, literal meaning to the concept of "dirty money." As a result, my teeth were in terrible shape.

I had known better. Back in 1971, publisher Stewart Brand had invited Ken Kesey and me to co-edit *The Last Supplement to the Whole Earth Catalog.* Our managing editor, Hassler (Ron Bevirt's Merry Prankster name), introduced me to the fine art of flossing.

"I began cleaning between my teeth with dental floss, and then brushing carefully after every meal for the last nine years," he told me. "Dental floss is really important because it removes particles of food from between the teeth that can't be dislodged by the brush. It's this crap *between* the teeth that really causes decay."

Although I didn't practice what he preached, I immediately assigned him to write a piece about the process of flossing for *The Last Supplement*. After all, the *Whole Earth Catalog* was devoted to informing its readers about a variety of New Age tools. And floss was definitely a useful tool. "Floss comes in two thicknesses," Hassler wrote. "Thin, called Dental Floss; and thick, called Dental Tape. Recently, I found Dental Floss Unwaxed. All the floss and tape I've used in the past were waxed. I find that I prefer the waxed because it slips in and out between my teeth cleanly without leaving any of the floss behind, which I find to be a problem with unwaxed floss. I've realized the importance of my teeth in

the service of my habit. Munch, slurp, slobber, drool…"

In 1987, I was a keynote speaker at the annual International Society for Humor Studies conference, held in Tempe, Arizona. I had dinner with a group of five staffers from the Russian humor magazine *Krokodil* at the Holiday Inn. They all ordered the specialty of the house—pork ribs—which came with huge bibs. The editor was given a bib with the words "Miss America" on it. The art director got a bib with a big iconic "S" for Superman.

They were really getting a dose of our culture. As we walked along the salad bar, one of the Russians stopped at the corn chowder and asked me, "Is this typical American soup?" As the others gathered around, I didn't quite know how to answer. "I'm sorry, I don't know," I said. "I'm sure it's typical *somewhere* in the country." And then I remembered that multi-tasking man at the airport urinal. "In America," I told the Russian, "corn chowder comes with dental floss that has little pieces of corn embedded in it, so if you get hungry between meals you can floss and have a snack at the same time."

A few years before I met my wife, Nancy, she had gone to a dentist

who required all new patients to take a two-session course in flossing and oral health. Only when he was satisfied that patients would be capable of caring for their teeth properly would he then make their first cleaning appointment. Nancy learned the technique, and recently a friend named her "the Floss Queen." We came across an ad stating that "If you follow a vegan diet, you may opt for Eco-Dent's GentleFloss, which uses beeswax instead of animal products." Who knew?

The irony behind all this is that Medicare doesn't cover any dental procedures, even though dentists emphasize how bad teeth can cause illness in other, internal parts of the body. For example, a research team from Columbia University's School of Public Health released the results of a three-year study of 420 men and women, concluding that the improvement of gum health can help slow the development of atherosclerosis, the build-up of cholesterol-rich plaque along artery walls, which can lead to heart attacks and strokes.

I still regret that I would eat candy without flossing afterward. Especially a Clark Bar, which could cause a cavity *and* fill it simultaneously.

6. I had taped an interview on an electric recorder-transcriber, plus a battery-operated cassette recorder as a back-up precaution, which turned out to be an absolute necessity when the electric recorder conked out right in the middle.

Later on, I bought a new one to replace it, but first I had to get rid of the old one. My desk consisted of a wooden door supported by a couple of two-drawer filing cabinets. I was just too damn lazy to take all the equipment and books off the desk so that I could move the desk toward me and pull up the wire from behind it.

So I simply cut the wire with a pair of scissors. *Bzzzzzt!!!* I was shocked, but not injured. Though the recorder had conked out, I had incredibly left the wire still plugged into a socket on the surge protector. Where the scissors had cut the wire, parts of the metal had melted away just a couple of inches from my hand. I might've been electrocuted. *Yikes!*

I could've been killed, and the cause would've been a simple lack of the practice of mindfulness that I treasure so much. Instead, I had *emptied* my mind. Oops, wrong discipline. But I was still alive, and I thanked God for that. And then I heard a resplendent voice booming through the clouds: *"SHUT UP, YOU SUPERSTITIOUS FOOL!"*

Alternative Facts

Between the choice of a one-man-one-vote (Supreme Court Justice Antonin Scalia) and fake news of Weapons of Mass Destruction, invasion of Iraq, and horror of ISIS, George Bush was elected president in the year 2000. It was due to the electoral college (a rigged system which originally intended to prevent slaves from voting and evolved to gerrymandering), even though Bush's opponent, Al Gore, won the national popular vote.

Hillary Clinton was elected senator that year, and she announced that the first thing she would do was to get rid of the electoral college. A few years later, as a columnist for the *New York Press*, I sent her a letter asking about the status of that promise. She didn't reply.

On November 8, 2016, a crooked businessman, liar extraordinaire, bragging pussy-grabber, make-America-white-again, anti-choice, anti-Semite, false Christian, climate-change hoaxer, Nobamacare, homophobic, apprentice politician, fascist tweets, and Vladimir Putin's "useful idiot," namely Donald Trump, who was elected as an insanely narcissistic dictator based on the electoral college, whereas his opponent, Hillary Clinton, won the national popular vote by "more than three million" individuals.

Irony lives.

But an incredibly mean monster inadvertently awakened a sleeping

population to counteract the essence of evil with love, laughs, and law, fueled by the aid of true news. Incidentally, Putin had 88 journalists murdered. No wonder Trump told him, "It's an honor to be with you." Now Putin wanted Obama's new sanctions on Russia to be reprieved.

National Security Adviser Michael Flynn had discussed it with the Russian ambassador a month before Trump took office. Although General Flynn joined his campaign and shared criminal secrets, he denied them to the FBI. It was a felony offense. The Justice Department warned Trump that Flynn had misled Mike Pence, and that Flynn could be vulnerable to blackmail. Trump asked Flynn to resign, and yet he offered his job back when he got out of prison. Why? Because Flynn was the scapegoat, taking the fall for the president and vice-president. He preferred a trial with immunity since they knew all. Pence said Flynn lied and *that* was a lie.

If Trump and Pence were both to be kicked out of the White House, the next in line would be the Speaker of the House, Paul Ryan. Steve Bannon described him as "a limp-dick motherfucker who was born in a petri dish at the Heritage Foundation." In turn, Trunp's communicator Anthony Scaramucci boasted, "I'm not Steve Bannon, I'm not trying to suck my own cock." Ah, but Bannon said he wanted to *destroy* Ryan.

Hallelujah!

Trump once tried to patent "You're fired." Professional hater Bannon resigned. Back to running his *Breitbart News.* He had taken over the original right-wing website, *Breitbart.com,* after the death of editor Andrew Breitbart, who ironically was adopted and raised as a proud Jew.

Orson Bean is my oldest living friend. He became a Christian libertarian conservative, and we've had an ongoing email dialogue about religion, but he's still a Christian and I'm still an atheist. Not a militant atheist, as I used to be, though. I changed when I realized that Martin Luther King was a Christian, yet I was inspired by his actions, and George Lincoln Rockwell, head of the American Nazi Party, was an agnostic, yet I abhorred what he stood for. It no longer mattered to me what anybody's religious belief was, only how they treated others. Either kind or cruel. That simple.

I decided to email Orson: "If you can arrange for me to interview Andrew Breitbart"--his son-in-law--"I'll believe in God." Orson must've forwarded my email to Breitbart, because *he* sent me an email saying, "Apparently there is a God," with his own phone number. I called, we spoke, and he agreed to do an interview. My only ground rule would be that neither of us would interrupt the other. I contacted Steve Randall, my editor at *Playboy,* and I got the assignment. I immediately sent an email to Orson with the good news. The Subject line was "Praise the fucking Lord." Amen.

I Played Thomas Jefferson’s Violin

At a unique Heroes Convention, I met Lindsay Wagner, star of *The Bionic Woman.* She was unaware that the CIA served as technical adviser to her series, but she spoke poignantly of the positive influence that her TV alter-ego had on young amputees she visited in hospitals.

I also met Tom Laughlin, of *Billy Jack* movie fame. A couple of years later, he and his wife Delores Taylor invited me to a large dinner party.

They were Thomas Jefferson enthusiasts. In their home, there was Thomas Jefferson's furniture, Thomas Jefferson's silverware, Thomas Jefferson's recipes--we started with peanut soup--and even Thomas Jefferson's violin.

I mentioned playing the violin as a child, and Laughlin invited me to play this one. I hadn't held a violin for twenty-five years, not since I had used it as a prop when I started doing stand-up comedy, and four decades had passed since that concert in Carnegie Hall. It felt like a previous incarnation. But now Billy Jack himself was handing me Thomas Jefferson's violin. How could I resist?

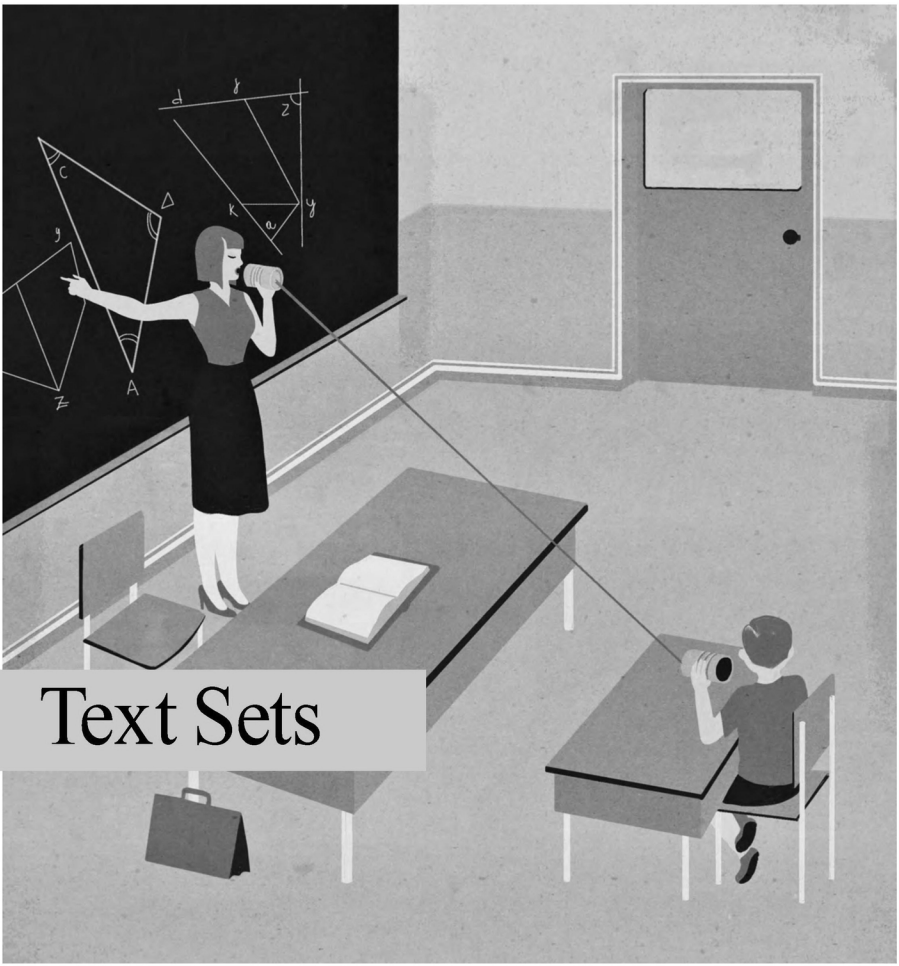
“I'd like to dedicate this to Thomas Jefferson's slaves,” I said.

And then I played the only thing I felt competent enough to perform-- "Twinkle, Twinkle, Little Star." While I was playing, I stood and, as unobtrusively as possible, balancing on my left foot, I scratched my left leg with my right foot.

It was a private joke between me and the god of Absurdity.

NAUTILUS

education



Text Sets

BETA PRODUCT Science Connected NAUTIL. US

Introducing *Nautilus* Education

The modern world has placed an unprecedented emphasis on science literacy. But most existing science texts do not emphasize literacy, and most literary texts don't have science.

This *Nautilus* Education text set pamphlet is a beta product intended to fill this gap. It contains three groups of articles from the award-winning science magazine, *Nautilus*, each accompanied by lesson plans and guides for teachers.

Key science concepts like genetics and astronomy are explored through narrative story telling and tailor-made artwork, letting science spill over its usual borders, and waking the imagination and interest of the student. This kind of literary science classroom material was designed to helps teachers satisfy the new U.S. common core and next gen standards but have global application. The relevant standards are listed in each lesson plan.

Nautilus is looking for partners interested in using and further developing this kind of content. For more information, please write to education@nautil.us.

—*Michael Segal*
Editor-in-Chief

About Nautilus Magazine

Nautilus is a new kind of science magazine. Each monthly issue tackles a single topic in contemporary science using multiple vantage points, from biology and physics to culture and philosophy. We are science, connected.

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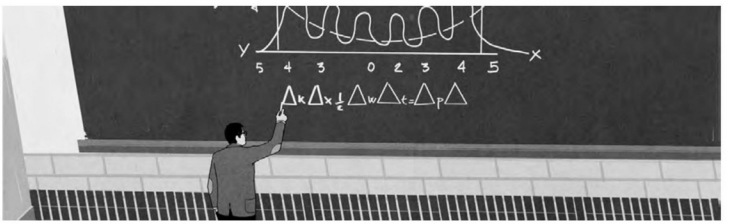

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SHOUT

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Astronomy & Space Travel

How would we travel nearly five light years? This article explores different engineering solutions to the puzzle of taking a very, very, long trip, intertwining science-fiction goals with real world solutions. Students will explore fanciful applications of Newton's second law, and concepts of momentum, ions, and nuclear fusion.

Lesson Plan

Review vocabulary words in class. Have students read the article and answer the reading comprehension questions for homework, as well as generate a discussion question of their own. In class, address any conceptual questions that the class might have. Have students write discussion questions on the board, along with the ones suggested in this document. Have students break up into small groups, each of which should address one of the discussion questions. 15 MIN

Dedicate the remaining class time to completing one of the activities. 30-45 MIN

Teacher's Notes: Roadmap to Alpha Centauri

VOCAB WORDS

Magnetic field: produced by a magnetic material or a current, a magnetic field will push or pull a moving charge or magnet that comes in contact with it.

Ion: an atom in which the number of electrons and protons is unequal—thus, the atom is positive or negative.

Momentum: the product of the mass and velocity of an object.

Recoil: the backward momentum from a fired gun.

Plasma: one of the four fundamental states of matter, composed of ions and electrons.

Nuclear fusion: when two or more clusters of neutrons and protons collide, forming a new nucleus and releasing energy.

READING COMPREHENSION

1. What does AU stand for?
2. How fast is Voyager 1 moving in miles per hour?
3. "The engine first strips propellant atoms [typically xenon] of their outermost electrons." What is the charge of a stripped xenon atom?

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4. What concept is at work in the ion drive? (Hint: what is conserved?)
5. What other travel options work on this principle?
6. How much momentum does an electron fired from a gun have?

DISCUSSION QUESTIONS

1. Why not take a traditional rocket to Alpha Centauri?
2. Which of the propulsion meturds listed is most likely to succeed? Would any be used together?
3. Would it be worth going if it took generations?
4. How far away is the next-nearest star?

ACTIVITIES

1. Research and create a brochure or ad enticing astronauts to make the trip. What would they eat? What psychological qualities would they need? If robots were sent, how would they be fixed? What kind of data could they expect to collect?
2. Propose another method of traveling to Alpha Centauri.

ADDITIONAL MULTIMEDIA

1. ***Voyager 1 Leaves the Solar System***
   (The Guardian) 1 MIN 45 SEC
   A quick explanation of where Voyager 1 is, and how scientists know its location: http://www.theguardian.com/science/video/2013/sep/13/voyager-1-leaves-solar-system-video
2. ***New Mars Rover Powered by Plutonium***
   (Space.com) 2 MIN 30 SEC
   An introduction to the nuclear battery on board the Mars Curiosity Rover, and the advantages of not using solar power (as with past missions): https://www.youtube.com/watch?v=1JOPW8aAcgEt

WHERE THIS FITS IN THE CURRICULUM

Structure and Properties of Matter (HS-PS1-8) Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

Forces and Interactions (HS-PS2-1) Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

Forces and Interactions (HS-PS2-2) Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

Engineering Design (HS-ETS1-3) Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

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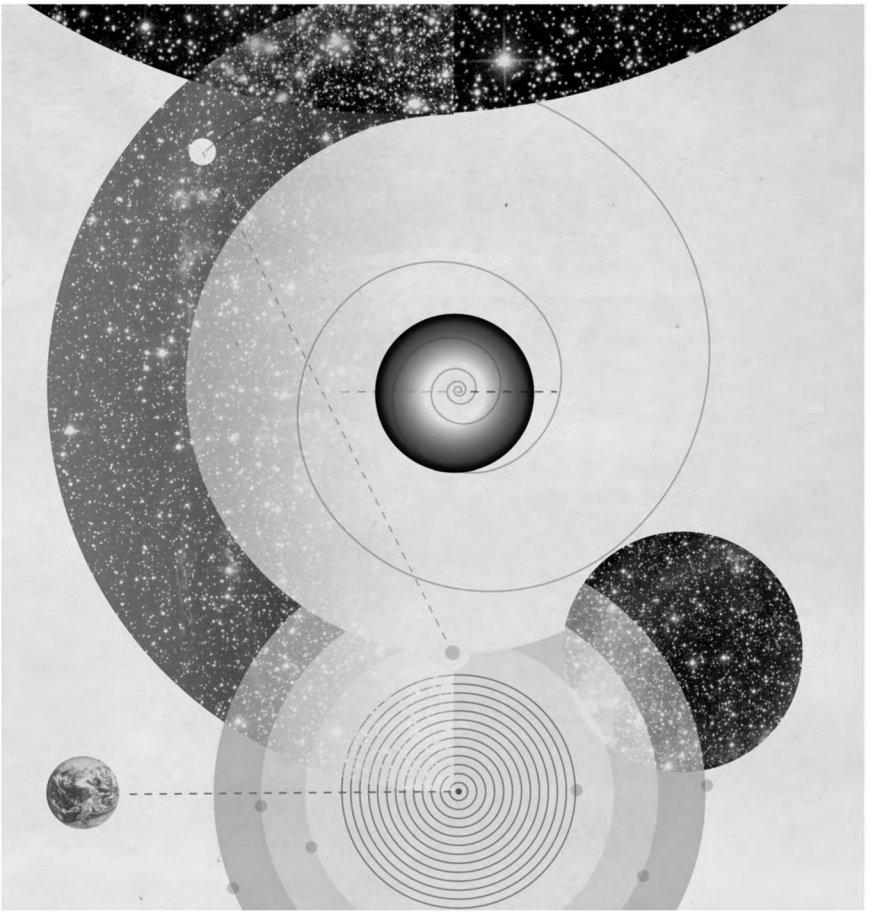

Roadmap to Alpha Centauri

Pick your favorite travel mode—big, small, light, dark, or twisted

BY GEORGE MUSSER

EVER SINCE THE DAWN of the space age, a quixotic subculture of physicists, engineers, and science-fiction writers have devoted their lunch hours and weekends to drawing up plans for starships, propelled by the imperative for humans to crawl out of our Earthly cradle. For most of that time, they focused on the physics. Can we really fly to the stars? Many initially didn't think so, but now we know it's possible. Today, the question is: *Will* we?

Truth is, we already *are* flying to the stars, without really meaning to. The twin Voyager space probes launched in 1977 have endured long past their original goal of touring the outer planets and have reached the boundaries of the sun's realm. Voyager 1 is 124 astronomical units (AU) away from the sun—that is, 124 times farther out than Earth—and clocking 3.6 AU per year. Whether it has already exited the solar system depends on your definition of "solar system," but it is certainly way beyond the planets. Its instruments have witnessed the energetic particles and magnetic fields of the sun give way to those of interstellar space—finding, among other things, what Ralph McNutt, a Voyager team member and planetary scientist, describes as "weird plasma structures" begging to be explored. The mysteries encountered by the Voyagers compel scientists to embark on follow-up missions that venture even deeper into the cosmic woods—out to 200 AU and beyond. But what kind of spacecraft can get us there?

Going Small: Ion Drives

NASA's Dawn probe to the asteroid belt has demonstrated one leading propulsion system: the ion drive. An ion drive is like a gun that fires atoms rather than bullets; the ship moves forward on the recoil. The system includes a tank of propellant, typically xenon, and a power source, such as solar panels or plutonium batteries. The engine first strips propellant atoms of their outermost electrons, giving them a positive electric charge. Then, on the principle that opposites attract,

ILLUSTRATION BY CHAD HAGEN

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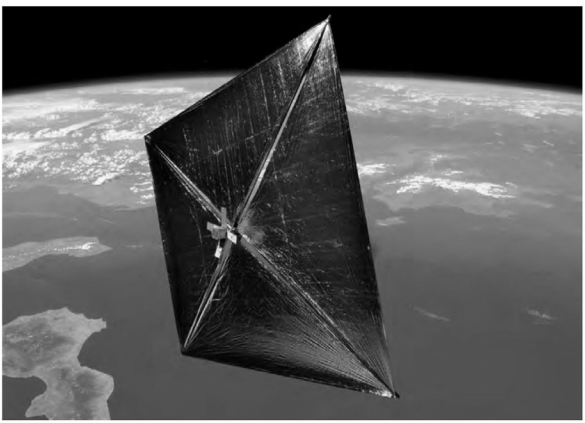

a negatively charged grid draws the atoms toward the back of the ship. They overshoot the grid and stream off into space at speeds 10 times faster than chemical rocket exhaust (and 100 times faster than a bullet). For a post-Voyager probe, ion engines would fire for 15 years or so and hurl the craft to several times the Voyagers' speed, so that it could reach a couple of hundred AU before the people who built it died.

Star flight enthusiasts are also pondering ion drives for a truly interstellar mission, aiming for Alpha Centauri, the nearest star system some 300,000 AU away. Icarus Interstellar, a nonprofit foundation with a mission to achieve interstellar travel by the end of the century, has dreamed up Project Tin Tin—a tiny probe weighing less than 10 kilograms, equipped with a miniaturized high-performance ion drive. The trip would still take tens of thousands of years, but the group sees Tin Tin less as a realistic science mission than as a technology demonstration.

Going Light: Solar Sails

A solar sail, such as the one used by the Japanese IKAROS probe to Venus, does away with propellant and engines altogether. It exploits the physics of light. Like anything else in motion, a light wave has momentum and pushes on whatever surface it strikes. The force is feeble, but becomes noticeable if you have a large enough surface, a low mass, and a lot of time. Sunlight can accelerate a large sheet of lightweight material, such as Kapton, to an impressive speed. To reach the velocity needed to escape the solar system, the craft would first swoop toward the sun, as close as it dared—inside the orbit of Mercury—to fill its sails with lusty sunlight.

Such sail craft could conceivably make the crossing to Alpha Centauri in a thousand years. Sails are limited in speed by how close they can get to the sun, which, in turn, is limited by the sail material's durability. Gregory Matloff, a City University of New York professor and longtime interstellar travel proponent, says the most promising potential material is graphene—ultrathin layers of carbon graphite.

A laser or microwave beam could provide an even more muscular push. In the mid-1980s, the doyen of interstellar travel, Robert Forward, suggested piggybacking on an idea popular at the time: solar-power satellites, which would collect solar energy in orbit and beam it down to Earth by means of microwaves. Before commencing operation, an orbital power station could pivot and beam its power up rather than down. A 10-gigawatt station could accelerate an ultralight sail—a mere 16 grams—to one-fifth the speed of light within a week. Two decades later, we'd start seeing live video from Alpha Centauri.

This "Starwisp" scheme has its dubious features—it would require an enormous lens, and the sail is so fragile that the beam would be as likely to fry it as to push it—but it showed that we could reach the stars within a human lifetime.

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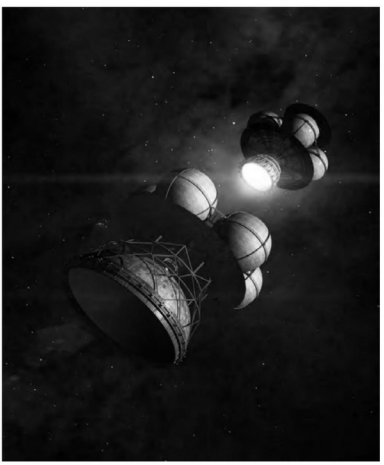
Going Big: Nuclear Rockets

Sails may be able to whisk tiny probes to the stars, but they can't handle a human mission; you'd need a microwave beam consuming thousands of times more power than the entire world currently generates. The best-developed scheme for human space travel is nuclear pulse propulsion, which the government-funded Project Orion worked on during the 1950s and '60s.

When you first hear about it, the scheme sounds unhinged. Load your starship with 300,000 nuclear bombs, detonate one every three seconds, and ride the blast waves. Though extreme, it works on the same basic principle as any other rocket—namely, recoil. Instead of shooting atoms out the back of the rocket, the nuclear-pulse system shoots blobs of plasma, such as fireballs of tungsten.



You pack a plug of tungsten along with a nuclear weapon into a metal capsule, fire the capsule out the back of the ship, and set it off a short distance away. In the vacuum of space, the explosion does less damage than you might expect. Vaporized tungsten hurtles toward the ship, rebounds off a thick metal plate at the ship's rear, and shoots into space, while the ship recoils, thereby moving forward. Giant shock absorbers lessen the jolt on the crew quarters. Passengers playing 3-D chess, or doing whatever else interstellar passengers do, would feel rhythmic thuds like kids jumping rope in the apartment upstairs.

The ship might reach a tenth the speed of light. If for some reason—solar explosion, alien invasion—we really had to get off the planet fast and we didn't care about nuking the launch pad, this would be the way to go. We already have everything we need for it. "Today the closest technology we have would be nuclear pulse," Matloff says. If anything, most people would be happy to load up all our nukes on a ship and be rid of them.

Ideally, the bomb blasts would be replaced with controlled nuclear fusion reactions. That was the approach suggested by Project Daedalus, a '70s-era effort to design a fully equipped robotic interstellar vessel. The biggest problem was that for every ton of payload, the ship would have to carry 100 tons of fuel. Such a behemoth would be the size of a battleship, with a length of 200 meters and a mass of 50,000 tons.

"It was just a huge, monstrous machine," says Kelvin Long, an English aerospace engineer and co-founder of Project Icarus, a modern effort to update the design. "But what's happened since then, of course, is microelectronics, miniaturization of technology, nanotechnology. All these developments have led to a rethinking. Do you really need these massive structures?" He says Project Icarus planned to unveil the new design in London in October 2013.

Interstellar designers have come up with all sorts of ways to shrink the fuel tank. For instance, the ship could use electric or magnetic fields to scoop up hydrogen gas from interstellar space. The hydrogen would then be fed into a fusion reactor. The faster the ship were to go, the faster it would scoop—a virtuous cycle that, if maintained, would propel the ship to nearly the speed of light. Unfortunately, the scooping system would also produce drag forces, slowing the ship, and the headwind of particles would cook the crew with radiation. Also, pure-hydrogen fusion is inefficient. A fusion-powered ship probably couldn't avoid hauling some fuel from

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Going Dark: Scavenging Exotic Matter

Instead of scavenging hydrogen gas, Jia Liu, a physics graduate student at New York University, has proposed foraging for dark matter, the invisible exotic material that astronomers think makes up the bulk of the galaxy. Particle physicists hypothesize that dark matter consists of a type of particle called the neutralino, which has a useful property: When two neutralinos collide, they annihilate each other in a blaze of gamma rays. Such reactions could drive a ship forward. Like the hydrogen scooper, a dark-matter ship could approach the speed of light. The problem, though, is that dark matter is dark—meaning it doesn't respond to electromagnetic forces. Physicists know of no way to collect it, let alone channel it to produce rocket thrust.

If engineers somehow overcame these problems and built a near-light-speed ship, not just Alpha Centauri but the entire galaxy would come within range. In the 1960s astronomer Carl Sagan calculated that, if you could attain a modest rate of acceleration—about the same rate a sports car uses—and maintain it long enough, you'd get so close to the speed of light that you'd cross the galaxy in just a couple of decades of shipboard time. As a bonus, that rate would provide a comfortable level of artificial gravity.

On the downside, hundreds of thousands of years would pass on Earth in the meantime. By the time you got back, your entire civilization might have gone ape. From one perspective, though, this is a good thing. The tricks relativity plays with time would solve the eternal problem of too-slow computers. If you want to do some eons-long calculation, go off and explore some distant star system and the result will be ready for you when you return. The starship crews of the future may not be voyaging for survival, glory, or conquest. They may be solving puzzles.

Going Warp: Bending Time and Space

With a ship moving at a tenth the speed of light, humans could migrate to the nearest stars within a lifetime, but crossing the galaxy would remain a journey of a million years, and each star system would still be mostly isolated. To create a galactic version of the global village, bound together by planes and phones, you'd need to travel faster than light.

Contrary to popular belief, Einstein's theory of relativity does not rule that out completely. According to the theory, space and time are elastic; what we perceive as the force of gravity is in fact the warping of space and time. In principle, you could warp space so severely that you'd shorten the distance you want to cross, like folding a rug to bring the two sides closer together. If so, you could cross any distance instantaneously. You wouldn't even notice the acceleration, because the field would zero out g-forces inside the ship. The view from the ship windows would be stunning. Stars would change in color and shift toward the axis of motion.

It seems almost mean-spirited to point out how far beyond our current technology this idea is. Warp drive would require a type of material that exerts a gravitational push rather than a gravitational pull. Such material contains a negative amount of energy—literally less than nothing, as if you had a mass of –50 kilograms. Physicists, inventive types that they are, have imagined ways to create such energy, but even they throw up their hands at the amount of negative energy a starship would need: a few stars' worth. What is more, the ship would be impossible to steer, since control signals, which are restricted to the speed of light, wouldn't be fast enough to get from the ship's bridge to the propulsion system located on the vessel's perimeter. (Equipment within the ship, however, would function just fi

When it comes to starships, it's best not to get hung up on details. By the time humanity gets to the point it might actually build one, our very notions of travel may well have changed. "Do we need to send full humans?" asks Long. "Maybe we just need to send embryos, or maybe in the future, you could completely download yourself into a computer, and you can remanufacture yourself at the other end through something similar to 3-D printing." Today, a starship seems like the height of futuristic thinking. Future generations might fi it quaint.

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george musser is a writer on physics and cosmology and author of *The Complete Idiot's Guide To String Theory* (Alpha, 2008). He was a senior editor at *Scientific American* for 14 years and has won honors such as the American Institute of Physics Science Writing Award.

HOUSE_OVERSIGHT_015471

Chemistry & Fuels

The matter in our world is recycled. The pair of articles here explores how elements and atoms wend their way through space and time. Students will explore how chemical reactions usher elements through their journeys. *You Are Made of Waste* illustrates, in five short vignettes, the lives of the elements that make up our teeth, fi breath, hair, and blood. *Frack 'er Up* is an in-depth look at the botched promise of biofuel—energy from cars made from renewable plant growth.

In the "curriculum" section of the teacher's notes, you will find information on how these pieces can help fulfill requirements of the Next Generation Science Standards. Specifically, they make for entry points to—or a means of reinforcing—lessons on photosynthesis, chemical reactions, valence electrons, and energy. But more than that, these lessons will connect to the students' daily lives, and spark discussion.

Lesson Plan:

Ask students to read one or both of the articles for homework. Briefly introduce or review the vocabulary words in class. Assign all or a selection of the reading comprehension questions for the students to complete along with the reading, and ask them to come up with one question for further discussion. (Note that a couple of the questions for each article are redundant.)

Start class with students raising any technical questions they might have about the readings. Ask them to contribute their discussion questions, and write these on the board, along with the questions provided in the teacher's notes. Ask the students to break into small groups; assign each group to address a question, and briefly present to the class for further discussion. 30-45 MIN

In the following class time (or another class) have the students complete one or more of the activities in the teacher's notes in small groups. 30 MIN

Teacher's Notes: You Are Made of Waste

VOCAB WORDS

Mass: a physical property that describes an object's resistance to force. The mass of an object can be used to calculate its weight: (mass) x (gravitational force) = weight.

Carbon: an element found in stars, planets, comets, as well as in all known living things.

Radioactive decay: the process by which a nucleus ejects alpha particles, particles of ionizing radiation. A nucleus that does this is considered "unstable;" a substance that contains unstable nuclei is considered "radioactive." This process usually only occurs in atoms heavier than iron.

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Fusion: when two or more nuclei collide, fusing to make a new nucleus and releasing energy. This process usually only occurs in atoms lighter than iron.

Chemical bond: an attraction between two or more atoms that allows them to form a substance of definite chemical composition. Breaking these bonds requires energy.

Petroleum: a "fossil fuel" that forms when organisms are crushed under rock and subjected to lots of pressure, and lots of time. Like the organisms it's made of, petroleum consists largely of carbon.

READING COMPREHENSION

1. "Each of those waste molecules is a carbon atom borne on two atomic wings of oxygen." Write out the chemical equation for the molecule described here.
2. "Organic" is used in two different ways in this piece. What are the two different definitions?
3. What does it mean for a chemical to be "highly reactive?" Identify oxygen's location on the periodic table, the group of atoms that it belongs to, and why they are considered "highly reactive."
4. Which elements on the periodic table are the least reactive?
5. "Fossil-based carbon dioxide molecules that are not soaked up by oceans or stranded in the upper atmosphere are eventually captured by plants, shorn of their oxygen wings, and woven into botanical sugars and starches." What is the process described here? (Hint: it is mentioned by name later in the piece.) Write down the equation for this reaction.

DISCUSSION QUESTIONS

1. "Chemophobia" is the fear of chemicals. What are some chemophobic practices or products that we engage with? Are there good reasons to be afraid of chemicals?
2. How does the story change the way you see yourself? Others?

ACTIVITIES

1. Pick an element not discussed in this article. Where else is it found? Where did it come from?
2. Draw a map or annotated illustration of all the places carbon goes in this article. Use outside research to complete a full picture of the carbon cycle.

ADDITIONAL MULTIMEDIA

1. ***Whose air do you share?***
   (It's OK To Be Smart, PBS) 3 MIN 30 SEC
   A video that explains how we breathe recycled air—including molecules of air exhaled by Einstein himself:
   https://www.youtube.com/watch?v=BybkIJysAKc
2. ***We Are Star Stuff segment***
   (Carl Sagan's Cosmos) 8 MIN
   Carl Sagan explains how the elements of life were born in stars, evolved into simple organisms, then into us: intelligent creatures, capable of exploring the stars we came from:
   https://www.youtube.com/watch?v=iE9dEAx5Sgw
3. ***The Microbes We're Made Of***
   (Smithsonian.com) 2 MIN 30 SEC
   We're not just made of waste. We're made of trillions of other organisms. This video provides a quick exploration of the microbiome crucial to keeping our bodies working, and what we're doing to kill them:
   http://www.smithsonianmag.com/videos/category/3play_1/the-microbes-were-made-of/?no-ist

WHERE THIS FITS IN THE CURRICULUM

Chemical Reactions *(HS-PS1-2)* Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of chemical properties.

HOUSE_OVERSIGHT_015473

Matter and its interactions *(HS-PS1-1)* Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

From molecules to organisms: structure and processes *(HS-LS1-6)* Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

Ecosystems: Interactions, energy and dynamics *(HS-LS-3)* Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

Teacher's Notes: Frack 'er Up

VOCAB WORDS

Ethanol: also found in beer and wine, it is a kind of biofuel that is sometimes added to gasoline for use in automobiles. Ethanol can be made from corn, potatoes, or green plants. Its chemical formula is CH_3CH_2OH.

Biofuel: a fuel made from plants or other organisms, in recent time.

Biomass: material from recently living organisms.

Organic compound: a molecule containing carbon.

Hydrocarbon: Made of just hydrogen and carbon, these are the simplest kind of organic compound.

Octane: a highly flammable hydrocarbon, and component of gasoline. Its chemical formula is C_8H_{18}.

Catalyst: a component of a chemical reaction that helps facilitate the reaction, but is not used up.

READING COMPREHENSION

1. "Plant biomass absorbs carbon dioxide as it grows." What is the name of the process by which plants do this? Look up and write down the chemical reaction.
2. A polymer is a chain of molecules. Identify a kind of polymer in the story, and the monomer that composes it.
3. Plants need carbon dioxide for photosynthesis. What are some of the sources for this carbon dioxide?

DISCUSSION QUESTIONS

1. Why is it advantageous for companies to be green?
2. Would you pay more for gas—or any other product, say a shirt—from a "green" company? What if some of that company's practices were just as questionable as those of "dark" companies?
3. How would the world change if gasoline could be made cheaply from natural gas? Should we consider this technology to be progress given that natural gas has it's own environmental consequences.

ACTIVITIES

1. Have students construct a timeline of fuel. Ask them to include dates mentioned from the story, and to research and add other relevant information: like the moment in history when organisms die, the life cycle of a tree that contributed the author's container of Primus fuel.
2. Draw a map or annotated illustration of all the places carbon goes in this article. Use outside research to complete a full picture of the carbon cycle.
3. Write a 30-second ad convincing car drivers to pay a premium for green gasoline like Primus'. Include "fine print"—side effects, or caveats—as you see necessary.

ADDITIONAL MULTIMEDIA

1. ***Algae*** (The Guardian)
An interactive slide show that illustrates how biofuels are made out of algae:

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http://www.theguardian.com/environment/interactive/2008/jun/26/algae
https://www.youtube.com/watch?v=BybkIJysAKc

2. ***Bioprospecting*** (TED-Ed) 4 MIN
An animated video introducing the concept of biofuels, and how they could help reduce reliance on our planet's limited supply of fossil fuels:
http://ed.ted.com/lessons/biofuels-and-bio-prospecting-for-beginners-craig-a-kohn

3. ***The Microbes We're Made Of*** (Smithsonian.com) 2 MIN 30 SEC
We're not just made of waste. We're made of trillions of other organisms. This video provides a quick exploration of the microbiome crucial to keeping our bodies working, and what we're doing to kill them:
http://www.smithsonianmag.com/videos/category/3play_1/the-microbes-were-made-of/?no-ist

WHERE THIS FITS IN THE CURRICULUM

Matter and energy in organisms and ecosystems *(HS-LS1-5)* Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

History of the Earth *(HS-ESS1-6)* Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.

Chemical reactions *(HS-PS1-2)* Construct and revise an explanation for the outcomes of simple chemical reactions based on the outermost electron state of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

Ecosystems: Interactions, energy and dynamics *(HS-LS-3)* Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

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You Are Made of Waste

Searching for the ultimate example of recycling? Look in the mirror

BY CURT STAGER

YOU MAY THINK OF YOURSELF as a highly refined and sophisticated creature—and you are. But you are also full of discarded, rejected, and recycled atomic elements. Don't worry, though—so is almost everyone and everything else.

Carbon: Your inky nails

Look at one of your fingernails. Carbon makes up half of its mass, and roughly 1 in 8 of those carbon atoms recently emerged from a chimney or a tailpipe. Coal-fired power plants, petroleum-guzzling cars, and kitchen gas stoves release carbon dioxide into the atmosphere. Each of those waste molecules is a carbon atom borne on two atomic wings of oxygen. Fossil-based carbon dioxide molecules that are not soaked up by the oceans or stranded in the upper atmosphere are eventually captured by plants, shorn of their oxygen wings, and woven into botanical sugars and starches. Eventually, some of them end up in bread, sweets, and vegetables, while others help form carbon-rich animal tissues, finding their way into meat and dairy products. Historically, atmospheric carbon dioxide was mainly replenished by volcanoes, forest fires, and biotic respiration. Today, one quarter of atmospheric CO_2 is the result of fossil fuel combustion, whether it rose from smokestacks or was displaced from the oceans. (When fossil-fuel CO_2 dissolves into ocean water, it displaces already-dissolved carbon dioxide derived from natural sources.) And because all of the carbon in your body derives from ingested organic matter, which in turn obtains it from the atmosphere, your fingernails and the rest of the organic matter in your body are built, in part, from emissions.

ILLUSTRATIONS BY YUKO SHIMIZU

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Radioactive Carbon-14: Your pearly whites

When you smile, the gleam of your teeth obscures a slight glow from radioactive waste. During the late 1950s and early 1960s, atmospheric testing of thermonuclear weapons scattered so much radioactive carbon-14 into the atmosphere that it contaminated virtually every ecosystem and human. Several thousand unstable radiocarbon atoms explode within and among your cells every second as their unstable nuclei undergo spontaneous radioactive decay. Some are the natural products of cosmic rays that can turn atmospheric nitrogen into carbon-14, while others result from the decay of unstable mineral elements that are found in soil. But many of them represent the echoes of thermonuclear airbursts from the Cold War, finding their way into our water supply and meals. If they happen to disintegrate within your DNA, they can damage your genes. And many of them are bound up in your teeth. Unlike most of the atoms in your body, those embedded in your strong, stable tooth enamel have been with you ever since you ingested them through your umbilical cord and your infant feeding. If you were born during the early 1960s, you have more nuclear waste in your teeth than if you were born later, when soils and oceans had had time to bury radioactive atoms. In fact, forensic scientists use the proportion of bomb carbon in tooth enamel to determine the age of unidentified human remains.

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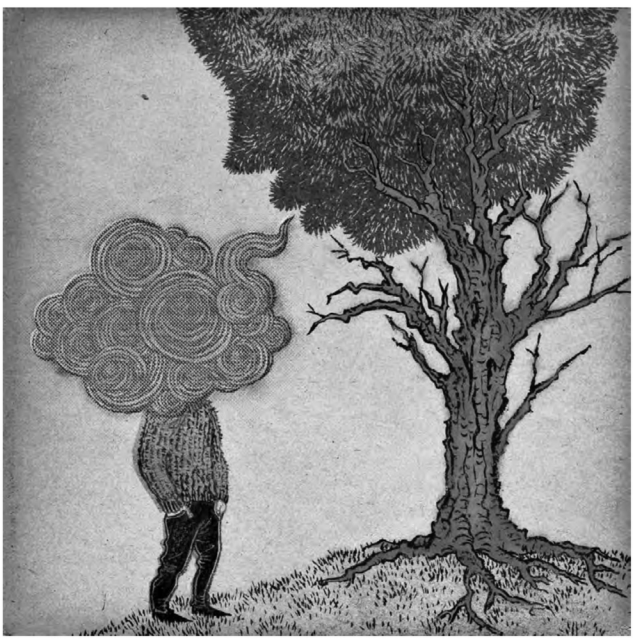
Oxygen: Your leafy breath

The oxygen in your lungs and bloodstream is a highly reactive waste product generated by vegetation and microbes. Trees, herbs, algae, and blue-green bacteria split oxygen atoms out of water molecules during photosynthesis. They use most of the resultant gas for their own purposes, but thankfully some leaks out to sustain you. In fact it makes up about a fifth of the air you breathe. Your cells harness oxygen to release energy from chemical bonds in the food you consume. Oxygen absorbs electrons released by broken food molecules, which attract hydrogen ions, resulting in a molecular waste of your own making: metabolic water, which comprises one tenth of your body fluids. An average adult carries between 8 and 10 pounds of homemade wastewater within them, and 1 in 10 of your tears are the metabolic by-products of your breathing and eating.



Nitrogen: Your natural curls

The next time you brush your hair, think of the nitrogenous waste that helped create it. All of your proteins, including hair keratin, contain formerly airborne nitrogen atoms. But the nitrogen in air is biologically inert. For nitrogen to become a component of your hair, it has to be converted into a more accessible form. Nitrogen-fixing bacteria is one way that can happen. They live among the roots of beans, peas, and other legumes, consuming atmospheric nitrogen and releasing it as ammonia, a kind of microbial manure that fertilizes soil in which plants grow. When you eat a plant, you consume formerly atmospheric nitrogen. Every flash of lightning and every automotive spark plug emits a puff of nitrogen oxide, which can dissolve into raindrops and fall to earth as a form of fertilizer, again finding its way into food webs through plants. But most of the nitrogen in modern foods comes from urea and ammonium nitrate fertilizers artificially fixed by industrial processes. In ages past, the nitrogen in human hair came mainly from bacterial waste and lightning. But today, unless you eat a strictly organic diet, you run your hairbrush through nitrogenous frameworks that are mostly of human origin.

Iron: Your ancient blood

When you cut yourself, the wreckage of stars spills out. Every atom of iron in your blood, which helps your heart shuttle oxygen from your lungs to your cells, once helped destroy a massive star. The fierce nuclear fusion reactions that set stars ablaze create the atomic elements of life. As the star ages, it fuses progressively larger elements, such as silicon, sulfur, and calcium. Eventually, iron atoms are fused. The problem is that iron fusion consumes as much energy as it produces, so it weakens the star. If the star is big enough, it will collapse in on itself, its outer layers rebounding against the dense inner core, and a supernova explosion will result. The blast sprays out iron at supersonic speeds, filling great swathes of space with debris that can form new solar systems. The iron in your frying pan, house keys, and blood is essentially cosmic shrapnel from the tremendous explosions that ripped through our galaxy billions of years ago. The same blasts also released carbon, nitrogen, oxygen, and other elements of life, which later produced the sun, the Earth, and eventually—you.

curt stager is an ecologist and climate scientist at Paul Smith's College. He is the author of *Deep Future: The Next 100,000 Years of Life On Earth*, and also co-hosts a weekly science program on North Country Public Radio.

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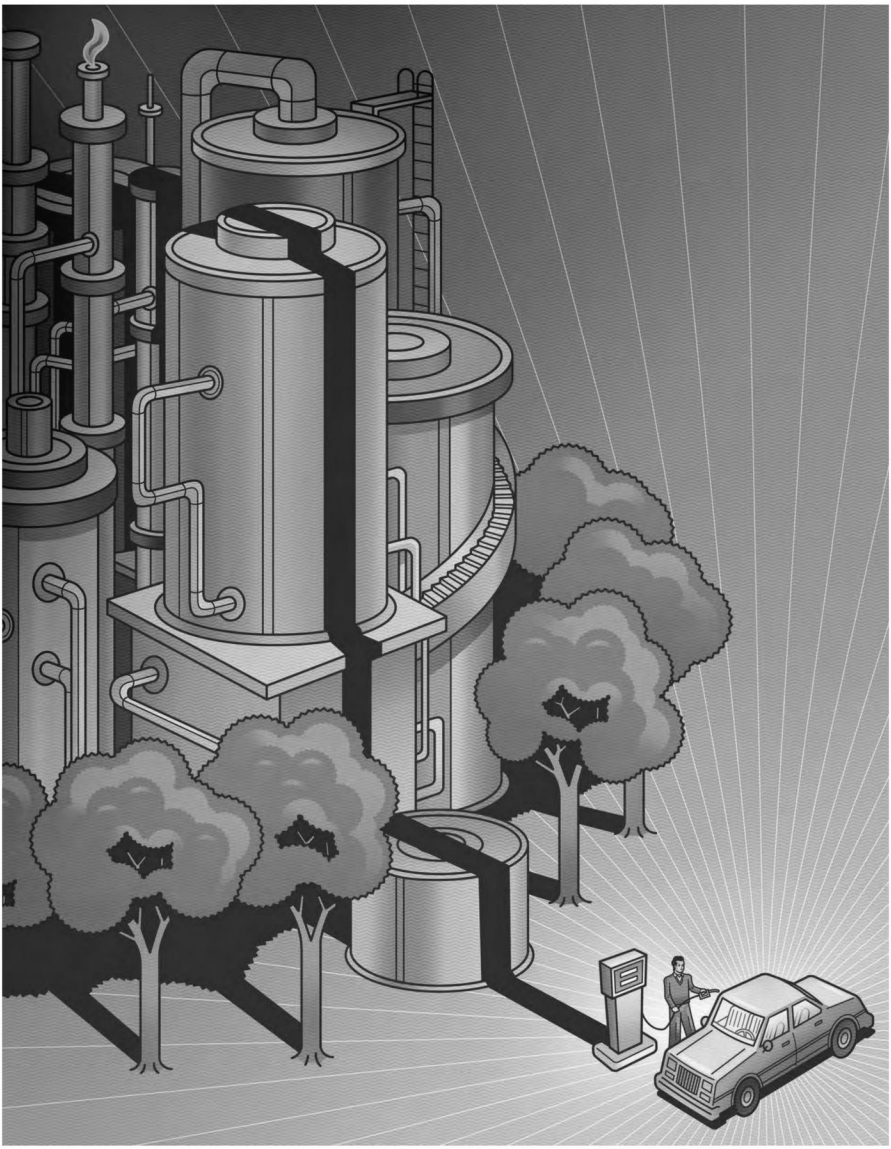

Frack 'er Up

Natural gas is shaking up the search for green gasoline

BY DAVID BIELLO

I AM SPEEDING DOWN New Jersey's highways, propelled by gasoline with a dash of ethanol, an alcoholic biofuel brewed from stewed corn kernels. As I drive through the outskirts of the township of Hillsborough, in the center of the state, I see that spring has brought with it a bounty of similar "biomass," as the fuel industry likes to call plants. Trees line the road and fresh-cut grass covers the sidewalks as I pull into the business park that is home to Primus Green Energy—a company that has been touting a technology to transform such biomass into a green and renewable form of gasoline.

But there's a hitch. The boom in hydraulic fracturing, or "fracking," a technique in which horizontal drilling and high-pressure jets of water are deployed to release gas trapped in sedimentary shale rock, has made natural gas cheap and plentiful. That's not bad for Primus, whose technology can make gasoline from natural gas, biomass, or even low-grade coal, such as lignite or peat. This versatility makes Primus a potential part of what has been called the "olive economy"—companies that are neither bright green nor darkest black, but combine environmentally-friendlier technologies with older and dirtier ones in order to compete. In fact, Primus may become a leader in advancing this kind of technology. "We can be as dark as you want or as green as you want," says geologist, serial entrepreneur, and Primus salesman George Boyajian.

In July, President Barack Obama gave a major speech on climate change that described natural gas as a "transition fuel" towards the "even cleaner energy economy of the future." But Primus's trajectory raises the question of whether natural gas is a boost on the road to a genuinely green fuel, or if it is prolonging our addiction to dirty modes of transport, and taking us on a detour from a low-carbon path.

At the Primus headquarters, I first meet Primus's chief chemist Howard Fang in front of a prototype of a Primus conversion machine. Fang, who joined the company for what he calls his "semi-retirement," is

ILLUSTRATION BY PETER & MARIA HOEY

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avuncular and black-haired. His interests are broad: He spends his spare time writing and reading history, and has authored books on conflict in the Middle East and the role of Christian missionaries in China.

A lifetime in fuels chemistry left Fang with one burning question: "What is the real solution to the energy crisis?" His career at oil companies BP and ExxonMobil, and engine manufacturer Cummins, spanned not just one but two major energy upheavals—the oil crisis of the 1970s and then its sequel in the first decade of the 21st century, which is arguably still ongoing. These experiences impressed on Fang the importance of securing the fuel supply in such a way as to avoid despoiling the environment. The solution, says the bespectacled chemist, is "nature-sourced biomass or natural gas converted effectively to gas or diesel."

Primus's original idea was simple: take scrap wood or other biomass, turn it into pellets, and apply pressure and heat (700 degrees Celsius or more) to break it down into hydrogen and carbon monoxide. Then build this composite "syngas," shorthand for "synthetic gas," back up into whatever hydrocarbon product is desired—the molecules of eight carbon and 18 hydrogen atoms known as iso-octane that are a measure of the quality of conventional gasoline, or the longer chains of similar hydrocarbons that comprise diesel or jet fuel. Because plant biomass absorbs carbon dioxide as it grows, the emissions produced by burning the biofuel should balance out overall—every molecule of CO2 emitted when the fuel is burned was previously absorbed by the plant that made the fuel.

The story of the search for such green fuel is littered with disappointments, however. Major companies brew ethanol in large quantities in the United States. It is routinely added to gasoline (at levels of around 10 percent, on its way to 15 percent) as a way to improve combustion, reduce pollution, and support industrial corn farmers. But most ethanol is still made from the edible kernels of corn plants, instead of the inedible cellulose that was promised in the heady days of the mid-2000s, when Congress passed a spate of laws promoting biofuel production. Since 1978, the ethanol industry has enjoyed subsidies and tax credits to the order of 40 cents per gallon, and now produces an annual dead zone at the mouth of the Mississippi River each summer as a result of fertilizer washing off the endless cornfields of the Midwest. But ethanol is unlikely to ever fully replace conventional fossil fuels, since it is more difficult to transport, produces a fraction of the energy of oil, and would require engines to be refitted or replaced on a massive scale.

Hence the interest in "drop-in" biofuels as a substitute for conventional fuels in existing cars, planes, and trucks. The problem is not one of infrastructure, but chemistry: Companies must find a way to economically imitate and fast-track a process for which time and geology have done most of the work in conventional fossil fuels. The energy in these fuels is the pent-up power of ancient sunlight, which billions of photosynthetic microorganisms soaked up before dying, fossilizing, and turning into the hydrocarbon-rich stew we know as petroleum, and from which we refine gas, diesel, and jet fuel, among other products. In theory, then, it should be possible to turn the carbohydrates and other chemicals that store energy for today's living things into the hydrocarbons we rely on for transportation.

Potential routes to such "green crude" include algae, other photosynthetic organisms, and specialty microbes engineered to spit out hydrocarbons. Biofuel company Solazyme has a contract to supply United Airlines with 20 million gallons of algal jet fuel, and teamed up with a green fuel-station network to offer biodiesel in a test run in San Francisco's Bay Area. But it takes a lot of water—and a lot of energy to move that water around—in order to grow algae in large quantities, and tailor-making microbes is expensive at its current scale. As a result, companies are diversifying. Algal fuel producer Sapphire Energy is now focusing on isolating the genetic traits in the ancestors of all plants that might be usefully incorporated into other crops. Solazyme is making oils and specialty fats to sell at high margins to cosmetics and food companies, as is would-be microbial fuel-maker Amyris. The industry for "advanced biofuels is literally in its infancy," concedes Jonathan Wolfson, Solazyme CEO.

The allure of Primus's technology is its promise to harness waste wood and other inedible biomass that would otherwise be thrown into landfills, and turn it into a renewable source of gasoline. Its "syngas to gasoline plus" process consists, essentially, of four

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"We can be as dark as you want or as green as you want," says Boyajian.

chemical reactors. One turns the syngas into methanol. The next makes methanol into a molecule known as dimethyl ether, or DME in chemist-speak. In the third reactor, catalysts known as zeolites knit DME into gasoline, in the most expensive and energy-intensive part of the process. The fourth reactor eliminates some of the unwanted byproducts that cause the resulting fuel to congeal at low temperatures.

The key is the zeolites, porous minerals made up of aluminum, silicon, and oxygen that allow the desired chemical reactions to take place. Both Primus and a conventional oil refinery employ zeolites to manipulate hydrocarbons. At an oil refinery, these catalysts help crack and sort hydrocarbons broken down from crude oil. At Primus, heat and pressure allow zeolites to build gasoline hydrocarbons from the smaller molecules of syngas. Such "catalysts are a bit of a dark art," says Boyajian. He spars with Fang over whether or not the company will one day make their own. Fang does not accept Boyajian's need for secrecy, and would be more than happy to reveal all those dark arts—a prospect that makes the affable Boyajian nervous and tight-lipped. For now, the fledgling company buys the necessary catalysts off the shelf and must sign agreements not to examine these zeolites too closely.

Using different catalysts in the reactors, Fang notes, the company could spit out diesel or jet fuel instead of gasoline. And for every 100 kilograms of syngas, he says, Primus can make 30 kilograms of gasoline or more, using a continuous looping system within the machine that eliminates the need for wasting energy to convert gases to liquids along the way. Little red containers of Fang-made gasoline record its characteristics, scrawled on masking tape affixed to the sides: low vapor pressure, a higher-than-average octane content of around 93, and a favorable absence of sulfur or benzene. Oil prices have been rising over the last month, and are currently at more than $100 per barrel; the company estimates that its gasoline costs as little as that derived from oil at $65 per barrel—and could

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cost as little as $2 per gallon, or about half the price gas currently goes for at local pumps, to produce at a full-sized facility, even though such an industrial plant would require a lot of capital to build.

However, the machine Fang shows me is not running on the biomass that Fang originally tested: wood chips, switchgrass, canary grass, miscanthus. Instead, it churns through natural gas, turning methane into syngas. Making long hydrocarbons from the single carbon in methane molecules is "very easy," he assures me. But "natural gas is not true green," he concedes. "There is no benefit in [the reduction of] greenhouse gases. Biomass is still true green."

Natural gas from the fracking boom has revolutionized the global energy landscape—particularly in the United States, the world's biggest producer of shale gas. But it is also controversial. Gas burns cleaner, but it still produces around half the greenhouse emissions of its dirtier cousins like coal, not including the excess methane that leaks from fracking sites and the pipelines that transport the gas. Fracked gas can also contaminate groundwater supplies. And while in 2012 it brought America's carbon footprint down to its lowest level in 20 years, relying on it in the long-term will make it hard to eliminate greenhouse gas emissions, as is required to combat climate change.

As the price of natural gas slid in response to the glut of shale gas, Primus changed gears in mid-2012 to move away from biomass and to focus on making syngas from natural gas. This is not a new idea: ExxonMobil built a plant in New Zealand in 1986 to turn natural gas into methanol and then gasoline, but abandoned its efforts when the price of petroleum dropped dramatically in the mid 1990s. Now, though, natural gas is cheap and attractive. Boyajian has a map of all the shale formations in North America tacked to the wall of his office. "The world is full of shale," he notes.

An earlier version of Primus' machine, tuned to process biomass, sits swathed in silvery insulating tape in a locked and darkened lab. "Right now it is abandoned," Fang says. The company insists that the statement doesn't apply to Primus's biomass efforts more generally. "This is the way to get to biofuels," says Primus CEO Robert Johnsen, of the gas to gasoline process, through a tight smile. "Will we be the ones to get there? Maybe."

The energy in these fuels is the pent-up power of ancient sunlight, which billions of photosynthetic microorganisms soaked up before dying.

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Will natural gas be a bridge for Primus to green fuel, or will it be too cheap and attractive to resist as a permanent substitute for biomass? For the moment, the company seems keen to squeeze what it can out of the shale gale. With the help of more than $50 million in Israeli money, Primus is building a demonstration plant the size of a house near its headquarters in New Jersey, due to open this year. The location is off the map—even Google won't guide you there, as if it were some secretive skunk works facility, which is how the company likes to think of it. The plant will take natural gas from the local utility, run it through its proprietary set of chemical reactions and, on the far end, out of a spigot, will come gasoline—12.7 gallons per hour at full capacity. The company's first commercial plant, due to start construction next year, will likely be located near a source of natural gas.

Scaling up the technology this way will reduce the overhead costs per unit of gasoline—that is, the cost of fabricating the reactors and buying the zeolites and feedstocks. Plus, Primus' technology may prove economical enough at a scale small to allow its plants to be distributed close to remote natural gas wells or even sources of biomass. It is no coincidence that the company based itself in verdant New Jersey, "the Garden State"; proximity to biomass is crucial for producers, because transporting heavy and unwieldy wood or corn stalks across large distances tends makes the end product too costly and undercuts the greenhouse-gas savings that are a large part of its appeal.

As I prepare to drive off, Fang carts out one of his collection of red plastic gas cans and dumps a liter or so of Primus-made, natural gas-to-gasoline fuel into my tank. A test car tooled around on it last summer, with no problems. The hope is to be able to charge a premium for the higher-octane premium product. "People pay twice as much for organic food," Boyajian says. "So why not pay more for green gasoline?" My fuel sensor can tell the difference: it registers an anomalously high miles-per-gallon number.

Fang gives me two thumbs up as I pull away, watching me drive off on his preferred solution to the energy crisis. It's unclear whether Primus will ever find the occasion to turn back towards biogasoline—and whether that's a long-term fix for the world's energy and environmental conundrum. Striving to make cleaner fuel for standard, dirty combustion engines may reinforce drivers' loyalty to today's technology. Such lock-in makes a true revolution difficult until some alternative energy source—whether battery-driven electric cars or engines modified to burn carbon-neutral, as-yet-unmade biofuels—offers the kind of convenience and low cost that justifies replacement.

At present, Primus appears set to become part of a sprawling infrastructure that reinforces the incentives to use greenhouse gas-producing, gasoline-like fuels. And for all those concentrated octanes in my tank, I still have to pull into a Shell station to fill up on conventional gasoline, blended with corn ethanol, in order to drive home.

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david biello is the Environment and Energy Editor for *Scientific American*. He is currently working on a book about the Anthropocene.

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Genetics & Human Health

Since DNA is often heralded as the "code of life," what clues can mutations—changes to the DNA sequence—tell us about human health and disease? The pair of articles in the Genetics and Human Health module will explore the consequences of mutations in the context of cancer treatment and rare diseases such as muscular dystrophy. *Their Giant Steps to a Cure* discusses the challenges associated with treating a rare form of muscular dystrophy. *An Unlikely Cure Signals Hope for Cancer* explores how specific mutations in a patient's cancer can be used to a patient's advantage.

Lesson Plan

Ask students to read both of the articles for homework. Briefly introduce or review the vocabulary words in class. Assign the questions listed under "Reading Comprehension" for them to complete along with the reading and ask them to come up with one question for further discussion.

Start class by asking students if they have any questions about the readings. Ask them to contribute their discussion questions (in addition to the ones provided under Deep Thinking / Discussion questions). Have the class brainstorm and answer both discussion questions. 15 MIN.

Next, break the class up into four groups for the Suggested Activity. Assign each group to one protein that is listed in the interactive. 15 MIN.

Have each group present their thoughts to the class for further discussion. 15 MIN.

Teacher's Notes: Their Giant Steps to a Cure, and An Unlikely Cure Signals Hope for Cancer

VOCAB WORDS

Muscular dystrophy: a genetic disease marked by progressive weakening of the muscles. Some forms of muscular dystrophy are seen in infancy or childhood.

Orphan diseases: diseases that have yet to be "adopted" by the pharmaceutical industry because there are very few incentives to develop new medications to treat or prevent them. Orphan diseases can be rare or they are common diseases that have been ignored (e.g.: tuberculosis, cholera, typhoid, malaria).

Calpainopathy: a rare type of muscular dystrophy characterized by symmetric and progressive weakness of proximal (limb-girdle) muscles.

Cancer: A term used to describe disease in which abnormal cells divide without control and are able to invade into other tissues. Cancers are often categorized based on the organ or cell type they originate in.

Oncologist: A doctor who specializes in treating patients with cancer.

Outlier: An observation that deviates from a majority and can be seen to be a rare event. In the context of this piece, the outliers are patients who respond

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to therapy when the same therapy has failed other patients.

Remission: a decline or disappearance of signs and symptoms of cancer.

READING COMPREHENSION

1. Why are orphan diseases underfunded?
2. How does the mutation in calpain 3 cause muscle to fail to grow?
3. What are some reasons pharmaceutical companies would want to develop drugs for orphan diseases? What are some possible reasons they would be against doing so?
4. Statistically speaking, outliers are often ignored. In this story, why is patient number 45 such an interesting case? Why is it generally important to study the outliers of response?
5. Which protein's activity is blocked by everolimus? What is the function of this particular protein?

DISCUSSION QUESTIONS

1. In what contexts would it be desirable and undesirable to sequence your genome to see if you are at risk for a disease? What are the benefits and downsides of knowing if you are at risk for a particular disease?
2. In both pieces, mutations are responsible for causing disease. Compare and contrast the ways mutations can lead to muscular dystrophy and cancer. Are the mutations in one case hereditary? Are mutations leading to either disease caused by environmental factors? Are the mutations in either case preventable? If so, how could they be prevented?
3. How should doctors and scientists decide whether to work on a rare condition?

ACTIVITIES

Some genes are not specific to humans, but rather, are common to myriad species. In a smaller group, you will be assigned to read about one of the proteins listed here: http://nautil.us/issue/5/fame/genes-that-won-the-fame-game

Please answer the following questions when it is your turn to present to the class:

1. What organisms is the gene present in? Were you surprised by the presence of the gene in any of the organisms listed? If so, why?
2. If this protein was mutated, what could the consequences look like? Could it cause a disease?
3. Research and present one other case of an outlier being useful in science or medicine.

WHERE THIS FITS IN THE CURRICULUM

Structure and Function (HS-LS1-1) A cell contains genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells.

Variation of Traits (HS-LS3-2) Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Mutations can, in turn, cause disease and/or affect human health. The pattern of mutations can also predict response to drugs.

Inheritance and Variation of Traits - Environmental Factors (HS-LS3-3) Technological advances have influenced the progress of science and science has influenced advances in technology. Technologies have evolved to sequence human genes, which can better inform doctors of their patients' health. Likewise, pharmaceutical companies have also created many drugs for the treatment of human disease.

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Their Giant Steps to a Cure

Battling a rare form of muscular dystrophy, a family finds an activist leader, and hope

BY JUDE ISABELLA

IN 2007, AT HER high school graduation in Quesnel, British Columbia, Ivana Topic stood at the top of the auditorium stairs, her long gown skimming the floor, her dark brown hair spilling over her shoulders. She had on ridiculously high heels. As she eased down the stairs, very slowly, she hung on to her date. She was afraid her knees would collapse, as her muscles were weak for her age.

From the audience, Ivana's mother, Marijana, watched her daughter's every step, silently panicking and breaking into a sweat. She knew Ivana could easily tumble down the stairs and break a limb. The year before, Ivana had been diagnosed with muscular dystrophy, an incurable genetic disease characterized by progressive weakening of the muscles. Antonia, Ivana's younger sister by five years, was later diagnosed with the same disease.

Around the time of Ivana's graduation, the Topics, an unassuming family originally from Croatia, had begun adjusting their lives as best they could, inquiring about ramps everywhere they went, avoiding walking in snow and sleet. For years, Ivana and Antonia had been subjected to endless medical tests. In 2010, they learned they had a rare form of muscular dystrophy, calpainopathy, which affects about 1 in 200,000 people. The diagnosis meant both would likely be bound to wheelchairs while they were still young women.

Today, Ivana is 24. In May, she graduated from college with a bachelor's degree in finance and general business. She still walks up stairs in her house; her bedroom is upstairs. "I'm definitely a fighter, and will try and walk for as long as I can," she says. "When I notice I'm falling a lot, when I need help a lot, I will go in a chair."

Muscular dystrophy treatment is limited to only palliative medications and therapies. Ivana herself practices yoga. While researchers worldwide are working on lasting cures for muscular dystrophy (funded in part by the famous Jerry Lewis Telethons), rare forms like calpainopathy are "orphans," with only a fraction of

ILLUSTRATIONS BY ELLEN WEINSTEIN

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"I'm definitely a fighter, and will try and walk for as long as I can."

researchers and funds devoted to them. With quiet stoicism, the Topics have accepted that modern medicine may not have a solution for their daughters' disease. Still, says Marijana, "Without hope, there's no life."

Following a current grassroots trend in medicine, many individuals with orphan diseases do not wait for the medical industry to care about them. Facing long odds, they are forced to raise money to find a potential cure themselves. But the Topics live by modest means. Marijana runs a daycare center and her husband and the childrens' father, Niko, works for a lumber company. They are in no position to mount a quest.

But then there's Michele Wrubel, 49, a stay-at-home parent from Connecticut who has calpainopathy. For years, Wrubel has been a passionate crusader for a cure. Affluent and well connected, she doesn't varnish the truth about what it has taken to make the medical industry pay attention to her. "To make a difference in this disease, you need money and meetings," she says. "Researchers are not going to study a disease unless there's money behind it to fund the research." For the Topics, Wrubel may be their best hope.

THE GLOBAL GENES PROJECT, an advocacy group, estimates 350 million people suffer from orphan diseases worldwide. Most rare diseases are genetic and tend to appear early in life. About 30 percent of children who have them die before reaching their fifth birthday. The rest battle their conditions throughout life, as most orphan diseases have no cure. Out of the 7,000 orphan diseases identified to date, with about 250 new ones added annually, less than 400 can be treated therapeutically.

This year the European Commission gave 144 million euros to develop 200 new therapies and the National Institute of Health allocated $3.5 billion to research orphan diseases. Yet some diseases are so rare that they remain stepchildren even among orphans. As a result, they receive little research attention and funding. Neither do they fit the list of billable insurance procedures. There's no standard healthcare path to diagnosis, let alone treatment. Similar to the Topics, many patients go through an ordeal, which Marijana describes as "a blur," only to find out that medicine can't help them.

Orphan disease organizations, such as the National Organization for Rare Disorders and the Rare Disease Foundation, encourage patients to take matters into their own hands. "Families have to advocate," says Isabel Jordan, chair of the Rare Disease Foundation. She encourages patients to form organizations, find new methods of funding, and push for research.

"Push for research" could be Michele Wrubel's calling card. She was diagnosed with muscular dystrophy in her mid-20s. But even though calpainopathy was identified nearly 20 years ago—about the same time Wrubel got her initial diagnosis—it took almost the entire second half of her life to determine that she was afflicted with calpainopathy. There were no clinical procedures that would lead to a diagnosis.

"It took a really long time and a very concerted effort," says Wrubel, who walks with canes, submitting to a wheelchair for long trips or when in crowded places. "If you don't know what you're looking for, they don't know what to tell you or how to help you," she says.

In 2008, gene sequencing came of age, which aided physicians in diagnosing muscular dystrophy subtypes. That year, Wrubel's husband, Lee, who holds a medical degree and a master's in public health from Tufts, an MBA from Columbia University, and is a venture capitalist in the medical field, tracked down a neurologist

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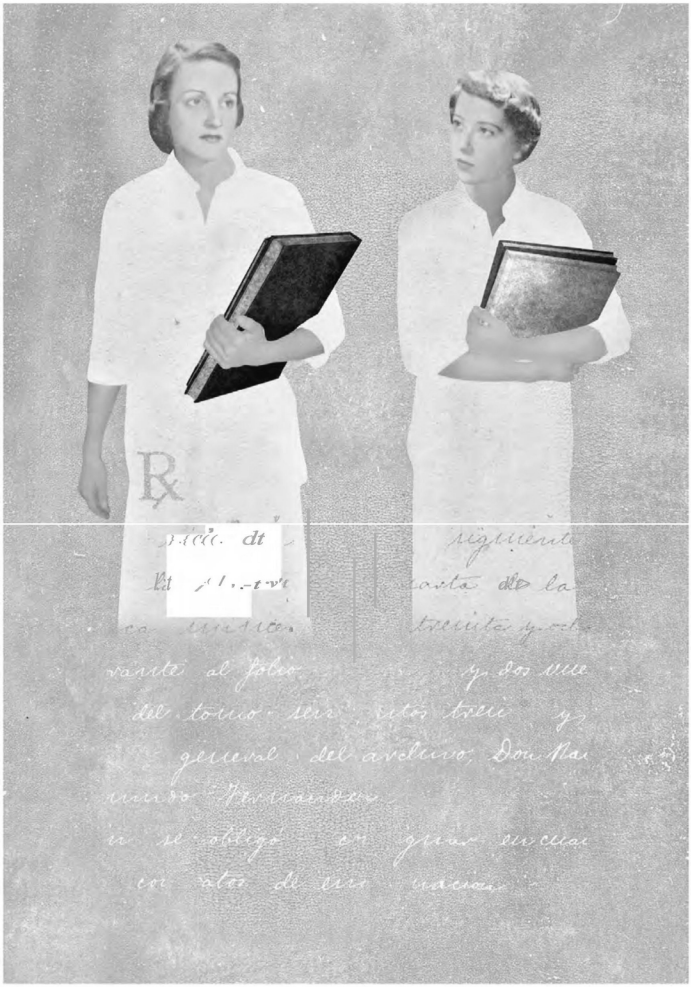

In the quest for a cure, she says, "It's a matter of patients taking charge of their diagnosis."

to sequence his wife's genomes. He paid several thousand dollars from his own pocket to learn his wife had calpainopathy.

The Topics had no such luxury. But they did have luck. Cornelius Boerkoel, a clinical geneticist at the University of British Columbia, enrolled the Topics in one of his studies, and so they didn't have to pay to have each of the family member's genomes sequenced. The genome tests gave Ivana and Antonia the bad news about calpainopathy. Their younger brother, Mario, is free of the disease.

Scientists classify calpainopathy, or "calpain," as a limb-girdle muscular dystrophy Type 2a, caused by a mutation in the gene calpain 3, predominantly expressed in skeletal muscle. Those who suffer from Type 2a, such as Wrubel, Ivana, and Antonia, generally exhibit weak hip flexors—muscles that lift up the thigh. The weak flexors give them an awkward gait; they swing their legs forward, landing on their toes, and then sometimes on the sides or soles of their feet. Some walk only on the balls of their feet. The upper body muscle weakness creates abnormally prominent shoulder blades.

Melissa Spencer from the University of California, Los Angeles, who has studied calpainopathy for 14 years, explains that the disease contains many subtypes. The problem with Type 2a, she says, "was a

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really strange gene mutation that was completely inexplicable." She says it has been a hard disease to study, partially because the implicated protein is unstable and partially because it was a rarity among the orphan diseases. When it comes to funding, calpainopathy has been overshadowed by other forms of muscular dystrophy. "Muscle studies have been underfunded forever and certainly a rare disease like 2a especially underfunded," Spencer says.

In 2010, Wrubel formed the nonprofit Coalition to Cure Calpain 3. In the quest for a cure, she says, "It's a matter of patients taking charge of their diagnosis." She reached out to other sufferers via Facebook, and some donated money. She partnered up with two other nonprofits that had raised funds on their own, both started by those afflicted with Type 2a. So far Wrubel's efforts have gathered close to half a million dollars. With that money, she has funded a project with Louis Kunkel, professor of genetics and pediatrics at Boston Children's Hospital, one of the nation's key muscular dystrophy researchers.

Her coalition also organized a conference to bring calpainopathy researchers together, including Spencer. Years earlier, in 2005, Spencer made a significant breakthrough. She discovered that calpainopathy, unlike more common forms of muscular dystrophy, was not a weakening of the muscle but a growth problem—muscle forms, but fails to grow because of a missing protein. It is different from other muscular dystrophies in which the lack of the protein complex, dystrophin, damages muscle membranes. "With calpainopathy, the muscles lack the growth signal," she says. "It's not transmitted properly." That difference makes a drug cure more possible. "I think this is going to be the easiest muscular dystrophy to cure," she says.

Encouraged by the promise, the Coalition to Cure Calpain 3 gave Spencer's lab a $260,000 grant to investigate how to circumvent the signaling problem and come up with a drug to fix it. But because the United States Food and Drug Administration already has a library of approved compounds that stimulate cell growth in muscle, Spencer's team may arrive at a solution sooner. With the help of the coalition's money, her lab is now plowing through the thousands of existing compounds, choosing those fit for testing. "I think it will be five years before we start thinking about clinical trials," Spencer says—and then another five years before the drugs can be commercially available, she estimates.

Wrubel's coalition intends to get pharmaceutical companies interested, too. "Many pharmaceutical companies see treating orphan diseases as a way to increase profits," Wrubel says. Her husband, Lee, adds, "The whole model for big pharmaceutical companies going forward is different. There is too little in the big pharmaceutical pipeline, and they're looking to feed that beast as much as possible." A 2012 Thomson Reuters study found that drug companies stand to profit from orphan drugs because, compared to drugs for common afflictions, they often have shorter and less expensive clinical trials, with more success. Spencer says a drug for calpainopathy, for instance, would also be useful for patients with Lou Gehrig's Disease and bed rest patients, as it would help arrest the loss of bone and muscle mass. Wrubel hopes to bring Cydan Development, a venture-capital backed orphan drug developer, to their upcoming fall conference in the Netherlands.

As for the Topics, they were excited to learn about Wrubel from *Nautilus*. Ivana recently connected with Wrubel through Facebook. "I only talked with her a little bit, but she seems ambitious and driven," Ivana says. "Definitely not someone who is going to sit around and wait for something to happen. Definitely inspiring. And the possibility that something might help in any way is a good thing to hear, for sure." Ivana says she now wants to get involved and advocate for her own disease. "I definitely want to do something," she says, and Wrubel's coalition "would be a good place to start."

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An Unlikely Cure Signals New Hope for Cancer

How "exceptional responders" are revolutionizing treatment for the deadly desease

BY KAT MCGOWAN

JUST LIKE EVERY NEW drug the oncologists at Memorial Sloan-Kettering Cancer Center tested against bladder cancer in the last 20 years, this one didn't seem to be doing any good. Forty-four people in the study were given everolimus in a last-ditch attempt to slow down or stop their advanced cancer. When the researchers analyzed the data, they could see that the drug wasn't slowing or stopping tumor growth. Everolimus seemed to be another bust.

Then there was patient number 45. She joined the trial with advanced metastatic cancer. Tumors had invaded deep into her abdomen, clouding her CT scan with solid grey blotches. She was 73 years old. None of the standard bladder cancer drugs were working for her anymore; she had "failed treatment," in the dismal lingo of oncologists. She enrolled in the study only because she happened to be a patient at Sloan-Kettering in January 2010. In April 2010, her cancer was gone.

This sort of happy surprise is not unheard of in drug studies. Bodies are fluky, each with its own idiosyncratic combination of genetic blueprints and environmental inputs. So sometimes a patient will be cured by a drug that is useless for everyone else. In the past, these spectacular reactions were written off as outlier responses that defied explanation—medical mysteries. Doctors just shrugged their shoulders and thanked their lucky stars that even though the study tanked, they did manage to help one person.

But this time was different. Clinical oncologist David Solit, director of developmental therapeutics at Sloan-Kettering, saw a new opportunity to explain what happened by sequencing the whole genome of the woman's cancer. Just five years ago, decoding and analyzing all 3 billion bases of the DNA from a tumor would've been absurdly time-consuming and expensive. Now the sequencing takes as little as a few days.

Poring over the outlier patient's genetic code, Solit pinpointed two mutations that made her tumor sensitive to this drug. He found that one of her mutations shows up in about 8 to 10 percent of other bladder cancer patients, meaning that they too might be helped by everolimus. His success has inspired a whole set of

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programs to study "exceptional responders": those rare cancer patients who do well while nobody else does.

Cancer is a personal disease, Solit explains. Each tumor constitutes its own world of defective genes and proteins. By studying the genetic quirks of exceptional responders, physicians can systematically identify weaknesses in cancer subtypes and blast them with drugs that target their unique vulnerabilities. "It's a testament to how much has been learned about the genome in the past 30 years," Solit says. "We've always wanted to find out why some individuals respond so well. Now we have the capacity. It's going to really change the way we treat patients."

UNLIKELY CASES HAVE AN eminent history in medicine. The modern science of the mind owes a lot to the freakish accident suffered by Phineas Gage, a 19th century railroad construction foreman whose job involved packing down explosive powder with a three-and-a-half-foot-long iron tamping rod. On Sept. 13, 1848, the powder exploded in his face, blasting the rod up through his chin and out the back of his head. Against all odds, he survived. But his personality was transformed. The formerly shrewd and patient Gage became obnoxious and unreliable.

An observant doctor named John Martyn Harlow who cared for Gage proposed that his personality change was due to the destruction of the frontal lobe of the left side of the brain. Gage's unlikely transformation revealed a universal truth about brains, that particular parts—the frontal lobes—are required for self-control. The strange case of Phineas Gage is still mentioned in neuroscience textbooks.

Rare events can also lead to new cures. As the story goes, English physician Edward Jenner's observations of an 18th century milkmaid who caught cowpox and thereby became immune to smallpox paved the way for the fi vaccines. New ideas for curing HIV are emerging from the famously unlucky lucky case of the "Berlin patient." Timothy Ray Brown, who was HIV positive, developed blood cancer leukemia in 2006. His chemotherapy and radiation treatments wiped out the cells of his immune system, where the virus is believed to hide. He then got a bone marrow transplant from one of those rare people with a gene mutation that makes them resistant to HIV. Today, Brown still has no sign of HIV in his body, and his case has inspired a study to genetically engineer HIV-positive patients' cells to resist the virus.

In the past, cancer researchers weren't able to capitalize on their unexpected outlier successes. Not enough was known about the biology of cancer, and the right tools hadn't been invented. "Even if someone had a complete remission, you had no way to figure out why," says James Doroshow, director of the Division of Cancer Treatment and Diagnosis of the National Cancer Institute (NCI). That changed in the 2000s, when it became possible to analyze the genetics of cancer tumors for clues.

The first major success came with studies of the drug gefitinib in non-small-cell lung cancer (the most common kind). Gefitinib helped less than 20 percent of the people who took it, but a few outliers had dramatic, rapid recoveries. In 2004, two Harvard groups found that the responders had mutations in the epidermal growth factor receptor (EGFR) gene. EGFR is one of many genes that regulates how cells grow and when they die, and the mutation basically forced it to pump out two or three times as much growth signal as it should, fueling the cancer. Gefitinib dialed down the signal. A clinical trial later proved that the drug keeps tumors at bay for more than nine months in people with certain EGFR mutations.

More insights gleaned from extraordinary responders soon followed. One melanoma patient in a study of 22 people taking sorafenib saw his tumor shrink quickly, a response due to a mutation in the gene KIT, which regulates cell growth, division and survival. People with certain kinds of melanoma, such as the type that grows on mucus membranes, now routinely get tested for this mutation. The drug helps about 40 percent of those with the mutation—an impressive advance in a cancer that once had no effective treatment.

In these studies, investigators had to make educated guesses about where in the genome to look for the culprit mutations. It was the keys-under-the-lamppost phenomenon: They could only examine genes they already suspected were involved in the cancer. But as the speed and efficiency of DNA sequencing skyrocketed, and its price plummeted, it started to look reasonable to sequence the whole tumor genome to cast the widest possible net. By 2010, when the bladder cancer

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patient (who doesn't want her name made public) had such a wonderful response to everolimus, the technology was ripe to analyze her entire tumor.

The outlier patient had already gone through several rounds of treatment, including surgery at Memorial Sloan-Kettering. That was another stroke of luck because it allowed Solit's group to acquire samples of her tissue to be sequenced. Cancers typically start with mutations that cause cells to divide too much, ignoring normal stop signals and evading quality controls that repair or prevent errors in DNA reproduction. "Cancer is a disease of mutations," says Solit.

The outlier patient's cancer had accumulated 17,136 mutations, of which 140 seemed most suspect, because they appeared in "coding" regions of the genome, the segments that include instructions on how to build the proteins that do the work in a cell. Out of those 140, two looked particularly menacing to Solit. In a gene called TSC1, just two of its 8,600 DNA base-pairs were missing, but the error would cause the gene to make a defective version of the protein it was supposed to create. In the gene NF2, an error meant a protein would be built only halfway, unable to do its job.

Solit could now see how these mutations were affected by everolimus, a drug typically used to suppress the immune system after organ transplants, and to combat advanced kidney cancer. Everolimus shuts down one crucial link in a chain of interacting proteins called the mTOR pathway that fuels cell growth, division, and survival. The drug inhibits the cells of the immune system from dividing, which they must do in order to attack foreign tissue, and protects transplanted organs. Likewise, it slows down the uncontrolled cell division that happens in cancer. The kicker was that both of the woman's mutations, NF2 and TSC1, affect the mTOR system. "It's not surprising, in retrospect, that our patient responded really well to this specific drug," Solit says. "She had the mutation that activated the pathway the drug targets."

Solit's team analyzed 13 more people from the trial and found different TSC1 mutations in three other people, including two whose tumor shrank a little in response to the drug. (Nobody else had NF2 mutations, which is probably why she alone responded dramatically.) Meanwhile, eight of nine people whose tumors grew during the study did not have the mutation.

DOROSHOW OF THE National Cancer Institute says Solit's work "turned on the lightbulb." It showed how the analysis of exceptional responders could be made systematic. Inspired by his example, the NCI is now trawling through its own archives, revisiting outlier responses among the roughly 10,000 patients who enrolled in NCI-sponsored clinical trials during the last decade. Picture the long rows of crates in the government warehouse at the end of *Raiders of the Lost Ark*: There's treasure in there somewhere, if only someone would look. "We ought to study these people more, since we have the means now," says Barbara Conley, the associate director of the cancer diagnosis program at NCI, who leads the project.

In the few months since the project began, Conley's team have already found about 100 exceptional responders. The next steps are to find out if their tumors were biopsied, if that tissue sample is still sitting in a freezer somewhere, and whether it's in good enough shape to be sequenced. Starting next year, the group will start inviting any scientist who is doing a clinical trial to submit new cases.

The NCI project will include whole-genome sequencing (provided they have adequate tissue samples) and repeated reads of the whole "exome"—the 1 percent of human DNA that is translated into exons, the sequences that are used as templates for protein construction. The reason to do both, explains Conley, is that cancer cells, even within a single tumor, often have a hodgepodge of mutations. Re-doing whole exome sequencing dozens of times captures most of the significant genetic variation in one tumor, and it's more practical than trying to sequence the whole genome over and over. Finally, RNA expression will also be analyzed. Evaluating RNA, an intermediary between DNA and proteins, provides a measure of which genes are switched on and how much protein they're producing.

Other elite cancer research centers and genome-sequencing centers have similar in-house projects. Much like the NCI project, the unusual responder program at the University of Texas, MD Anderson Cancer Center, is beginning by combing through the archives to hunt for outliers of the past. A patient at the clinic who has an unusual response—good or bad—will also be referred for genome sequencing and other kinds of genetic analysis.

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Even if each outlier case only applies to 3 or 7 percent of one type of cancer, as more cases are solved, the benefits quickly add up. "We're talking about small subsets of patients that together make a radical change," says Funda Meric-Bernstam, chair of the Department of Investigational Cancer Therapeutics at MD Anderson, who leads the unusual responders program. In some cases, existing cancer drugs can simply be repurposed, such as discovering that an immunosuppressant drug works for certain bladder cancers. Or it might mean finding new life for an experimental drug that had been abandoned. If Conley and Doroshow can pinpoint who might be helped by an abandoned drug, a pharmaceutical company might have to do just one or two further studies to get that drug approved for routine use.

The future might look something like what's been going on for several years at the Genome Institute of Washington University, where genome sequencing is being used to help people with relapsed cancers and who have run out of options. The project puts insights from studies like Solit's into practice, analyzing a patient's tumor to determine whether currently available drugs might target the troublemaker mutations. Combining whole genome sequencing, exome sequencing, and RNA expression analysis—what Washington University professor of genetics and Genome Institute co-director Elaine Mardis calls the "Maserati approach"—the team compares a comprehensive genetic profile against a database of drugs that target specific gene variants, looking for a match.

If there is a match, the results can be impressive, as was the case with a young Washington University doctor with leukemia, Lukas Wartman, who had suffered two relapses. In his case, analysis revealed that a gene called FLT3 was expressing more RNA than normal. A drug that inhibits this gene, usually used in kidney cancer, sent his cancer into remission. Washington University now has a special genetic test for patients with his type of leukemia.

Just recently, Solit's group solved another exceptional responder mystery—a case of ureteral cancer eliminated with a combination of old and new drugs. The old drug is a standard chemotherapy treatment that prevents DNA from unwinding, which it must do in order to duplicate itself during cell division. The new one sensitizes cells to the effects of radiation. This patient turned out to have a mutation in RAD50, involved in repairing broken DNA strands (badly repaired DNA can lead to uncontrolled cancerous growth). Here, too, the outlier finding may lead to a new treatment, since about 4 percent of the other tumors Solit has looked at have mutations that affect part of the RAD50 complex. "To look at these individuals' cancers can tell us a lot more than just a random case of cancer," says Solit. "There's a phenotype—a response—that gives you information about the genes."

Solit is now making a quick, reliable test for the TSC1 mutation to single out people with bladder cancer who might be helped by everolimus, and is planning a new study to test the drug in them. And the original outlier, the woman with bladder cancer? Three years later, she's still on everolimus and still having a "complete response," Solit says. She's doing fine.

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Game Theory and Morality

Moshe Hoffman, Erez Yoeli, and Carlos David Navarrete

Introduction

Consider the following puzzling aspects of our morality:

1. Many of us share the view that one should not use people, even if it benefits them to be used, as Kant intoned in his second formulation of the categorical imperative: "Act in such a way that you treat humanity, whether in your own person or in the person of any other, never merely as a means to an end, but always at the same time as an end" (Kant, 1997). Consider dwarf tossing, where dwarfs wearing protective padding are thrown for amusement, usually at a party or pub. It is viewed as a violation of dwarfs' basic dignity to use them as a means for amusement, even though dwarves willingly engage in the activity for economic gain. Many jurisdictions ban dwarf tossing on the grounds that the activity violates dwarfs' basic human rights, and these laws have withstood lawsuits raised by dwarfs suing over the loss of employment (!).
2. Charitable giving is considered virtuous, but little attention is paid to how just the cause or efficient the charity. For example, Jewish and Christian traditions advocate giving 10 % of one's income to charity, but make no mention of the importance of evaluating the cause or avoiding wasteful charities. The intuition that giving to charity is a moral good regardless of efficacy results in the persistence of numerous inefficient and corrupt charities. For example, the Wishing Well Foundation has, for nearly a decade, ranked as one of CharityNavigator.

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com's most inefficient charities. Yet its mission of fulfilling wishes by children with terminal illnesses is identical to that of the more efficient Make-A-Wish Foundation. Worse yet, scams masquerading as charities persist. One man operating as The US Navy Veteran's Association collected over 100 million dollars—over 7 years!—before anyone bothered to investigate the charity.

3. In every culture and age, injunctions against murder have existed. If there is one thing much of humanity seems to agree on, it's that ending the life of another without just cause which is among the worst of moral violations. Yet cultures don't consider the loss of useful life years in their definition, even though it is relevant to the measure of harm done by the murder. Why is our morality so much more sensitive to *whether* a life was lost than to how much life was lost?

There are numerous other examples of how our moral intuitions appear to be rife with logical inconsistencies. In this chapter, we use game theory to provide insight on a range of moral puzzles similar to the puzzles described above.

What Is Game Theory and Why Is It Relevant?

In this section, we review the definition of a game, and of a Nash equilibrium, then discuss how evolution and learning processes would yield moral intuitions consistent with Nash equilibria.

Game theory is a tool for the analysis of social interactions. In a game, the *payoff* to each *player* depends on their actions, as well as the actions of others. Consider the Prisoner's Dilemma (Chammah & Rapoport, 1965; see Fig. 1), a model that captures the paradox of cooperation. Each of two players chooses whether to cooperate or to defect. Cooperating reduces a player's payoff by $c > 0$ while increasing the other's payoffs by $b > c$. Players could be vampire bats with the option of sharing blood, or firms with the option of letting each other use their databases, or premed students deciding whether to take the time to help one another to study. The payoffs, b and c, may represent likelihood of surviving and leaving offspring, profits, or chance of getting into a good medical school.

Solutions to such games are analyzed using the concept of a Nash equilibrium[1]—a specification of each player's action such that no player can increase his payoff by deviating unilaterally. In the Prisoner's Dilemma, the only Nash equilibrium is for neither player to cooperate, since regardless of what the other player does, cooperation reduces one's own payoff.

[1] Note that we focus on the concept of Nash equilibrium in this chapter and not evolutionary stable strategy (ESS), a refinement of Nash that might be more familiar to an evolutionary audience. ESS are the Nash equilibria that are most relevant in evolutionary contexts. However, ESS is not well defined in many of our games, so we will focus on the insights garnered from Nash and directly discuss evolutionary dynamics when appropriate.

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	C	D
C	b-c	-c
D	b	0

Fig. 1 The Prisoner's Dilemma. Player 1's available strategies (C and D, which stand for cooperate and defect, respectively) are represented as *rows*. Player 2's available strategies (also C and D) are represented as *columns*. Player 1's payoffs are represented at the intersection of each row and column. For example, if player 1 plays D and player 2 plays C, player 1's payoff is b. The Nash equilibrium of the game is (D, D). It is indicated with a *circle*

Game theory has traditionally been applied in situations where players are rational decision makers who deliberately maximize their payoffs, such as pricing decisions of firms (Tirole, 1988) or bidding in auctions (Milgrom & Weber, 1982). In these contexts, behavior is expected to be consistent with a Nash equilibrium, otherwise one of the agents—who are actively deliberating about what to do—would realize she could benefit from deviating from the prescribed strategy.

However, game theory also applies to evolutionary and learning processes, where agents do not deliberately choose their behavior in the game, but play according to strategies with which they are born, imitate, or otherwise learn. Agents play a game and then "reproduce" based on their payoffs, where reproduction represents offspring, imitation, or learning. The new generation then play the game, and so on. In such settings, if a mutant does better (mutation can be genetic or can happen when agents experiment), then she is more likely to reproduce or her behavior imitated or reinforced, causing the behavior to spread. This intuition is formalized using models of evolutionary dynamics (e.g., Nowak, 2006).

The key result for evolutionary dynamic models is that, except under extreme conditions, behavior converges to Nash equilibria. This result rests on one simple, noncontroversial assumption shared by all evolutionary dynamics: Behaviors that are relatively successful will increase in frequency. Based on this logic, game theory models have been fruitfully applied in biological contexts to explain phenomena such as animal sex ratios (Fisher, 1958), territoriality (Smith & Price, 1973), cooperation (Trivers, 1971), sexual displays (Zahavi, 1975), and parent–offspring conflict (Trivers, 1974). More recently, evolutionary dynamic models have been applied in human contexts where conscious deliberation is believed to not play an important role, such as in the adoption of religious rituals (Sosis & Alcorta, 2003), in the expression and experience of emotion (Frank, 1988; Winter, 2014), and in the use of indirect speech (Pinker, Nowak, & Lee, 2008).

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Crucially for this chapter, because our behaviors are mediated by moral intuitions and ideologies, if our moral behaviors converge to Nash, so must the intuitions and ideologies that motivate them. The resulting intuitions and ideologies will bear the signature of their game theoretic origins, and this signature will lend clarity on the puzzling, counterintuitive, and otherwise hard-to-explain features of our moral intuitions, as exemplified by our motivating examples.

In order for game theory to be relevant to understanding our moral intuitions and ideologies, we need only the following simple assumption: *Moral intuitions and ideologies that lead to higher payoffs become more frequent*. This assumption can be met if moral intuitions that yield higher payoffs are held more tenaciously, are more likely to be imitated, or are genetically encoded. For example, if every time you transgress by commission you are punished, but every time you transgress by omission you are not, you will start to intuit that commission is worse than omission.

Rights and the Hawk–Dove Game

In this section we will argue that just as the Hawk–Dove model explains animal territoriality (Maynard Smith & Price, 1973, *to be reviewed shortly*), *the Hawk–Dove model sheds light onto our sense of rights* (Descioli & Karpoff, 2014; Gintis, 2007; Myerson, 2004).

Let us begin by asking the following question (Myerson, 2004): "Why [does] a passenger pay a taxi driver after getting out of the cab in a city where she is visiting for one day, not expecting to return?" If the cabby complains to the authorities, the passenger could plausibly claim that she had paid in cash. The answer, of course, is that the cabby would feel that the money the passenger withheld was his—that he had a right to be paid for his service—and get angry, perhaps making a scene or even starting a fight. Likewise, if the passenger did in fact pay, but the cabby demanded money a second time, the passenger would similarly be infuriated. This example illustrates that people have powerful intuitions regarding rightful ownership. In this section, we explore what the Hawk–Dove game can teach us about our sense of property rights.

The reader is likely familiar with the Hawk–Dove game, a model of disputes over contested resources. In the Hawk–Dove game, each player decides whether to fight over a resource or to acquiesce (i.e. play Hawk or Dove). If one fights and the other does not, the fighter gets the resource, worth v. If both fight, each pays a cost c and split the resource. That is, each gets $v/2-c$. If neither fights, they split the resource and get $v/2$. As long as $v/2<c$, then in any stable Nash equilibrium, one player fights and the other acquiesces. That is, if one player expects the other to fight, she is better off acquiescing, and vice versa (see Fig. 2).

Crucially, it is not just a Nash equilibrium for one player to always play Hawk and the other to always play Dove. It is also an equilibrium for both players to condition whether they play Hawk on an *uncorrelated asymmetry*—a cue or event that

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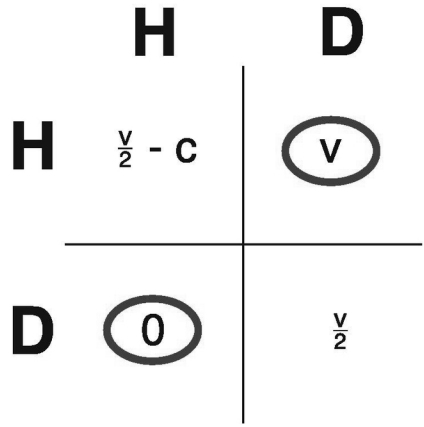

Fig. 2 The Hawk–Dove game. The Nash equilibria of the game are circled

does not necessarily affect the payoffs, but does distinguish between the players, such as who arrived at the territory first or who built the object. If one conditions on the event (say, plays Hawk when she arrives first), then it is optimal for the other to condition on the event (to play Dove when the other arrives first).

As our reader is likely aware, this was the logic provided by Maynard Smith to explain animal territoriality—why animals behave aggressively to defend territory that they have arrived at first, even if incumbency does not provide a defensive advantage and even when facing a more formidable intruder. Over the years, evidence has amassed to support Maynard Smith's explanation, such as experimental manipulation of which animal arrives first (Davies, 1978; Sigg & Falett, 1985).

Like other animals, we condition how aggressively we defend a resource on whether we arrive first. Because our behaviors are motivated by beliefs, we are also more likely to believe that the resource is "ours" when we arrive first. Studies have shown these effects with children's judgments of ownership, in ethnographies of prelegal societies, and in computer games. In one such illustration, DeScioli and Wilson (2011) had research subjects play a computer game in which they contested a berry patch. Subjects who ended up keeping control of the patch usually arrived first, and this determined the outcome more often than differences in fighting ability in the game.

This sense of ownership is codified in our legal systems, as illustrated by the quip "possession is 9/10ths of the law," and in a study involving famous legal property cases conducted by Descioli and Karpoff (2014). In a survey, these researchers asked participants to identify the rightful owner of a lost item, after reading vignettes based on famous property rights legal cases. Participants consistently identified the possessor of the found item as its rightful owner (as the judges had at the time of the case). This sense of ownership is also codified in our philosophical tradition, e.g., in Locke (1988), who found property rights in initial possession. Note that, as has also been found in animals, possession extends to objects on one's land: In DeScioli and

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Karpoff's survey, another dictate of participants' (and the judges') property rights intuitions was who owned the land on which the lost item was found.

Also like animals, our sense of property rights is influenced by who created or invested in the resource, another uncorrelated asymmetry. In locales that sometimes grant property rights to squatters—individuals who occupy lands others have purchased—a key determinant of whether the squatters are granted the land is whether they have invested in it (Cone vs. West Virginia Pulp & Paper Co., 1947; Neuwirth, 2005). Locke also intuited that investment in land is part of what makes it ours: In *Second Treatise on Civil Government* (1689), Locke wrote, "everyman has a property in his person; this nobody has a right to but himself. The labor of his body and the work of his hand, we may say, are properly his."

If the Hawk–Dove model underlies our sense of property rights, we would expect to see psychological mechanisms that motivate us to feel entitled to an object when we possess it or have invested in it. Here are three such mechanisms, which can be seen by reinterpreting some well-documented "biases" in the behavioral economics literature. The first such bias is the *endowment effect*: We value items more if we are in possession of them. The endowment effect has been documented in dozens of experiments, where subjects are randomly given an item (mug, pen, etc.) and subsequently state that they are willing to sell the mug for much more than those who were not given the mug are willing to pay (Kahneman, Knetsch, & Thaler, 1990). In the behavioral economics literature, the endowment effect has sometimes been explained by loss aversion, which is when we are harmed more by a loss than we benefit from an equivalent gain. However, the source of loss aversion is not questioned or explained. When it is, loss aversion is also readily explained by the Hawk–Dove game (Gintis, 2007).

A second bias that also fits the Hawk–Dove model is the *IKEA effect*: Our valuation of an object is influenced by whether we have developed or built the resource. The IKEA effect has been documented by asking people how much they would pay for items like Lego structures or IKEA furniture after randomly being assigned to build them or receive them pre-built. Subjects are willing to pay more for items they build themselves.

A third such bias that fits the Hawk–Dove model is the *sunk cost fallacy* (Mankiw, 2007; Thaler, 1980), which leads us to "throw good money after bad" when we invest in ventures simply because we have already put so much effort into them, arguably because our prior efforts lead us to value those ventures more.

Possession and past investment are not the only uncorrelated asymmetries that can dictate rights. Rights can be dictated by a history of agreements, as happens when one party sells another deed to a house or car, or, as in our taxicab example, by whether a service was provided. There are also countless examples in which rights were determined by perhaps unfair or arbitrary characteristics such as race and sex: Black Americans were expected to give up their seat for Whites in the Jim Crow South and women to hand over their earnings or property to their husbands throughout the ages.

Hawk–Dove is not just a post hoc explanation for our sense of rights; it also leads to the following novel insight: We can formally characterize the properties that

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uncorrelated asymmetries must have. This requires a bit more game theory to illustrate; the logic is detailed in the section on categorical distinctions but the implications are straightforward: Uncorrelated asymmetries must be discrete (as in who arrived first or whether someone has African ancestry) and cannot be continuous (who is stronger, whether someone has darker skin). Indeed, we challenge the reader to identify a case where our sense of rights depends on surpassing a threshold in a continuous variable (stronger than? darker than?). More generally, an asymmetry must have the characteristic that, when it occurs, every observer believes it occurred with a sufficiently high probability, where the exact level of confidence is determined by the payoffs of the game. This is true of public, explicit speech and handshakes, but not innuendos or rumors. (Formally, explicit speech and handshakes induce what game theorists term common p-beliefs.)

The Hawk–Dove explanation of our sense of rights also gives useful clarity on when there will be conflict. Conflict will arise if both players receive opposing signals regarding the uncorrelated asymmetry, such as two individuals each believing they arrived first, or when there are two uncorrelated asymmetries that point in conflicting directions, such as when one person invested more and the other arrived first. The former source of conflict appears to be the case in the Israeli–Palestinian conflict. Indeed, both sides pour great resources into demonstrating their early possession, especially Israel, through investments in and public displays of archeology and history. The latter source of conflict appears to be the case in many of the contested legal disputes in the study by DeScioli and Karpoff (2014) mentioned above. An example is one person finds an object on another's land. Indeed, this turns out to be a source of many legal conflicts over property rights, and a rich legal tradition has developed to assign precedence to one uncorrelated asymmetry over another (Descioli & Karpoff, 2014). As usual, we see similar behavior in animals in studies that provide empirical support for Maynard Smith's model for animal territoriality: When two animals are each given the impression they arrived first by, for example, clever use of mirrors, a fight ensues (Davies, 1978).

Authentic Altruism, Motives, and the Envelope Game

In this section, we present a simple extension of the Repeated Prisoner's Dilemma to explain why morality depends not just on what people do but also what they think or consider.

In the Repeated Prisoner's Dilemma and other models of cooperation, players judge others by their actions—whether they cooperate or defect. However, we not only care about whether others cooperate but also about their decision-making process: We place more trust in cooperators who never even considered defecting. To quote Kant, "In law a man is guilty when he violates the rights of others. In ethics he is guilty if he only thinks of doing so."

The Envelope Game (Fig. 3) models why we care about thoughts and considerations and not just actions (Hoffman, Yoeli, & Nowak, 2015). The Envelope Game

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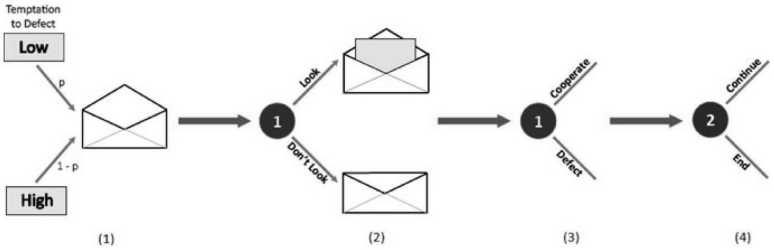

Fig. 3 A single stage of the Envelope Game

is a repeated game with two players. In each round, player 1 receives a sealed envelope, which contains a card stating the costs of cooperation (high temptation to defect vs. low temptation to defect). The temptation is assigned randomly and is usually low. Player 1 can choose to look inside the envelope and thus find out the magnitude of the temptation or choose not to look. Then player 1 decides to cooperate or to defect. Subsequently, player 2 can either continue to the next round or end the game. As in the Repeated Prisoner's Dilemma, the interaction repeats with a given likelihood, and if it does, an envelope is stuffed with a new card and presented to player 1, etc.

In this model, as long as temptations are rare, large, and harmful to player 2, it is a Nash equilibrium for player 1 to "cooperate without looking" in the envelope and for player 2 to continue if and only if player 1 has cooperated and not looked. We refer to this as the *cooperate without looking* (CWOL) equilibrium.[2] This equilibrium emerges in agent-based simulations of evolution and learning processes.[3] Notice that if player 1 could not avoid looking inside the envelope, or player 2 could not observe whether player 1 looked, there would not be a cooperative equilibrium since player 1 would benefit by deviating to defection in the face of large temptations. Not looking permits cooperative equilibria in the face of large temptations.

The Envelope Game is meant to capture the essential features of many interesting aspects of our morality, as described next.

Authentic Altruism. Many have asked whether "[doing good is] always and exclusively motivated by the prospect of some benefit for ourselves, however subtle" (Batson, 2014), for example, the conscious anticipation of feeling good (Andreoni,

[2] Technically, the conditions under which we expect players to avoid looking and attend to looking are $c_h > a/(1-w) > c_l p + c_h(1-p)$ and $bp + d(1-p) < 0$), where c_h and c_l are the magnitudes of the high and low temptations, respectively; p is the likelihood of the low temptation; $a/(1-w)$ is the value of a repeated, cooperative interaction to player 1; and $bp + d(1-p)$ is the expected payoff to player 2 if player 1 only cooperates when the temptation is low.

[3] The simulations employ numerical estimation of the replicator dynamics for a limited strategy space: cooperate without looking, cooperate with looking, look and cooperate only when the temptation is low, and always defect for player 1, and end if player 1 looks, end if player 1 defects, and always end for player 2.

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1990), avoidance of guilt (Cain, Dana, & Newman, 2014; Dana, Cain, & Dawes, 2006; DellaVigna, List, & Malmendier, 2012), anticipation of reputational benefits or reciprocity (as Plato's Glaucon suggests, when he proffers that even a pious man would do evil if given a ring that makes him invisible; Trivers, 1971). At the extreme, this amounts to asking if saintly individuals such as Gandhi or Mother Teresa were motivated thus, or if they were "authentic" altruists who did good without anticipating any reward and would be altruistic even in the absence of such rewards. Certainly, religions advocate doing good for the "right" reasons. In the Gospel of Matthew, Chapter 6, Jesus advocates, "Be careful not to practice your righteousness in front of others to be seen by them. If you do, you will have no reward from your Father in heaven," after which he adds, "But when you give to the needy, do not let your left hand know what your right hand is doing, so that your giving may be in secret. Then your Father, who sees what is done in secret, will reward you."

The Envelope Game suggests authentic altruism is indeed possible: By focusing entirely on the benefits to others and ignoring the benefits to themselves, authentic altruists are trusted more, and the benefits from this trust outweigh the risk of, for example, dying a martyr's death. Moreover, this model helps explain why we think so highly of authentic altruists, as compared to others who do good, but with an ulterior motive (consider, as an example, the mockery Sean Penn has faced for showing up at disaster sites such as Haiti and Katrina with a photographer in tow).

Principles. Why do we like people who are "principled" and not those who are "strategic"? For example, we trust candidates for political office whose policies are the result of their convictions and are consistent over time and distrust those whose policies are carefully constructed in consultation with their pollsters and who "flip-flop" in response to public opinion (as caricatured by the infamous 2004 Republican presidential campaign television ad showing John Kerry windsurfing and tacking from one direction to another). CWOL offers the following potential explanation. Someone who is strategic considers the costs and benefits to themselves of every decision and will defect when faced with a large temptation, whereas someone who is guided by principles is less sensitive to the costs and benefits are to themselves and thus less likely to defect. Imagine our flip-flopping politician was once against gay marriage but supports it now that it is popular. This indicates the politician is unlikely to fight for the cause if it later becomes unpopular with constituents or risks losing a big donor. Moreover, this model may help explain why ideologues that are wholly devoted to a cause (e.g., Hitler, Martin Luther King, and Gandhi) are able to attract so many followers.

Don't Use People. Recall Kant's second formulation of the categorical imperative: "Act in such a way that you always treat humanity, whether in your own person or in the person of any other, never simply as a means but always at the same time as an end." In thinking this through, let's again consider dwarf tossing. Many see it as a violation of dwarfs' basic dignity to use them as a means for amusement, even though they willingly engage in the activity for economic gain. Our aversion to using people may explain many important aspects of our moral intuitions, such as

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why we judge torture as worse than imprisonment or punishment (torture is harming someone as a means to obtaining information) and perhaps one of the (many) reasons we oppose prostitution (prostitution is having sex with someone as a means to obtaining money). The Envelope Game clarifies the function of adhering to this maxim. Whereas those who treat someone well as means to an end would also mistreat them if expedient, those who treat someone well as an end can be trusted not to mistreat them when expedient.

Attention to Motives. The previous two applications are examples of a more general phenomenon: that we judge the moral worth of an action based on the motivation of the actor, as argued by deontological ethicists, but contested by consequentialists. The deontological argument is famously invoked by Kant: "Action from duty has its moral worth not in the purpose to be attained by it but in the maxim in accordance with which it is decided upon, and therefore does not depend upon the realization of the object of the action but merely upon the principle of volition in accordance with which the action is done without regard for any object of the faculty of desire" (Kant, 1997). These applications illustrate that we attend to motives because they provide valuable information on whether the actor can be trusted to treat others well even when it is not in her interest.

Altruism Without Prospect of Reciprocation. CWOL also helps explain why people cooperate in contexts where there is no possibility of reciprocation, such as in one-shot anonymous laboratory experiments like the dictator game (Fehr & Fischbacher, 2003), as well as when performing heroic and dangerous acts. Consider soldiers who throw themselves on a grenade to save their compatriots or stories like that of Liviu Librescu, a professor at the University of Virginia and a Holocaust survivor, who saved his students during a school shooting. When he heard the shooter coming toward his classroom, Librescu stood behind the door to his classroom, expecting that when the shooter tried to shoot through the door, it would kill him and his dead body would block the door. Mr. Librescu, clearly, did not expect this act to be reciprocated. Such examples have been used as evidence for group selection (Wilson, 2006), but can be explained by individuals "not looking" at the chance of future reciprocation. Consistent with this interpretation, cooperation during extreme acts of altruism is more likely to be intuitive than deliberative (Rand & Epstein, 2014), and those who cooperate without considering the prospect of reciprocation are more trusted (Critcher, Inbar, & Pizarro, 2013). We also predict that people are more likely to cooperate intuitively when they know they are being observed.

The Omission–Commission Distinction and Higher-Order Beliefs

We explain the omission–commission distinction and the means–by-product distinction by arguing that these moral intuitions evolved in contexts where punishment is coordinated. Then, even when intentions are clear to one witness for omissions and by-products, a witness will think intentions are less clear to the other witnesses.

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Why don't we consider it murder to let someone die that we could have easily saved? For example, we sometimes treat ourselves to a nice meal at a fancy restaurant rather than donating the cost of that meal to a charity that fights deadly diseases. This extreme example illustrates a general phenomenon: that people have a tendency to assess harmful commissions (actions such as killing someone) as worse, or more morally reprehensible, than equally harmful omissions (inactions such as letting someone die). Examples of this distinction abound, in ethics (we assess withholding the truth as less wrong than lying (Spranca, Minsk, & Baron, 1991)), in law (it is legal to turn off a patient's life support and let the patient die, as long as one has the consent of the patient's family; however, it is illegal to assist the patient in committing suicide even with the family's consent), and in international relations. For example, consider the Struma, a boat carrying Jewish refugees fleeing Nazi persecution in 1942. En route to Palestine, the ship's engine failed, and it was towed to a nearby port in Turkey. At the behest of the British authorities then in control of Palestine, passengers were denied permission to disembark and find their way to Palestine by land. For weeks, the ship sat at port. Passengers were brought only minimal supplies, and their requests for safe haven were repeatedly denied by the British and others. Finally, the ship was towed to known hostile waters in the Black Sea, where it was torpedoed by a Russian submarine almost immediately, killing 791 of 792 passengers. Crucially, though, the British did not torpedo the ship themselves or otherwise execute passengers—an act of commission that they and their superiors would undoubtedly have found morally reprehensible.

Why do we distinguish between transgressions of omission and commission? To address this question, we present a simple game theory model based on the insight by DeScioli, Bruening, and Kurzban (2011). The intuition can be summarized in four steps:

1. We note that moral condemnation motivates us to punish transgressors. Such punishment is potentially costly, e.g., due to the risk of retaliation. We expect people to learn or evolve to morally condemn only when such costs are worth paying.
2. Moral condemnation can be less costly when others also condemn, perhaps because the risk of retaliation is diffused, because some sanctions do not work unless universally enforced or, worse, because others may sanction individuals they believe wrongly sanctioned. This can be modeled using any game with multiple Nash equilibria, including the Repeated Prisoner's Dilemma and the Side-Taking Game. The Coordination Game is the simplest game with multiple equilibria, so we present this game to convey the basic intuition. In the Coordination Game, there are two players who each simultaneously choose between two actions, say punish and don't punish. The key assumption is that each player prefers to do what she expects the other to do, which can be captured by assuming each receives a if they both punish, d if neither punish, $b<d$ if one punishes and the other does not, and $c<a$ if one does not punish while the other does (Fig. 4).
3. Transgressions of omission that are intended are difficult to distinguish from unintended transgression, as is the case when perpetrators are simply not paying

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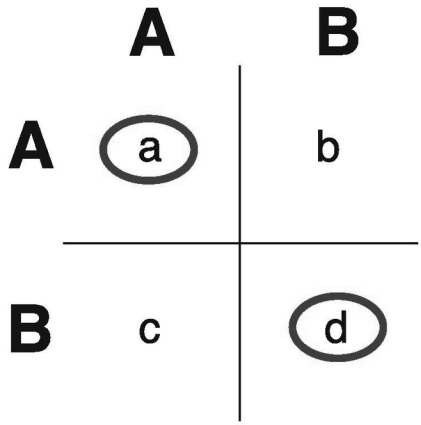

Fig. 4 The Coordination Game. In our applications, A stands for punish, and B stands for don't punish

attention or do not have enough time to react with better judgment (DeScioli et al., 2011). Relative to the example of the tennis player with the allergy described above, it is usually hard to distinguish between a competitor who does not notice his opponent orders the dish with the allergen versus one who notices but does not care. In contrast, transgressions of commission must be intended almost by definition.

4. Suppose the witness knows an omission was intentional: In the above example, the tennis player's opponent's allergy is widely known, and the witness saw the player watch his opponent order the offending dish, had time to react, thought about it, but did not to say anything. The witness suspects that others do not know the competitor was aware his opponent ordered the dish, but believes the tennis player should be condemned for purposely withholding information from his competitor. However, since the witness does not wish to be the sole condemner, she is unlikely to condemn. In contrast, when a witness observes a transgression of commission (e.g., the player recommends the dish), the witness is relatively confident that others present interpret the transgression as purposely harmful, since his recommendation reveals that the player was obviously paying attention and therefore intended to harm his opponent. So, if all other individuals present condemn the tennis player when they observe the commission, each does not anticipate being the sole condemner.

For the above result to hold, all that is needed is the following: (1) The more the costs of punishment decrease, the more others punish and (2) omissions are usually unintended (Dalkiran, Hoffman, Paturi, Ricketts, & Vattani, 2012; Hoffman et al., 2015).[4]

[4] In fact, even if one knows that others know that the transgression was intended, omission will still be judged as less wrong, since the transgression still won't create what game theorists call common p-belief, which is required for an event to influence behavior in a game with multiple equilibria.

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This explanation for the omission–commission distinction leads to two novel predictions: First, for judgments and emotions not evolved to motivate witnesses to punishment but to, say, motivate witnesses to avoid dangerous partners (such as the emotion of fear; in contrast to anger or moral disgust), the omission–commission distinction is expected to be weaker or disappear altogether. Second, for transgressions of omission that, without any private information, can be presumed intentional (such as a mother who allows her child to go hungry or a person who does not give to a charity after being explicitly asked), we would not expect much of an omission–commission distinction in moral condemnation.

As with the all models discussed in this chapter, the game theoretic explanation for the omission–commission distinction does not rest on rational, conscious, strategic calculation. In fact, in this particular case, all reasonable evolutionary dynamic models lead away from punishing omissions. The fact that the above results do not rest on rational, strategic thinking is particularly important in this setting since there is evidence that the distinction between omissions and commissions is not determined deliberately but rather intuitively (Cushman, Young, & Hauser, 2006) and appears to be evolved (DeScioli et al., 2011) and that consciously considering what others believe is an onerous process (Camerer, 2003; Epley, Keysar, Van Boven, & Gilovich, 2004; Hedden & Zhang, 2002).

This same model can explain several other puzzling aspects of our morality. The first is the *means–by-product* distinction. This distinction has been documented in studies that ask respondents to judge the following variants of the classic "trolley" problem. In the standard trolley "switch" case (Foot, 1967), a runaway trolley is hurtling toward a group of five people. To prevent their deaths, the trolley must be switched onto a side track where it will kill an innocent bystander. In studies using this case, the vast majority of subjects choose the utilitarian option, judging it permissible to cause the death of one to save five (e.g., Cushman et al., 2006; Mikhail, 2007). In the "footbridge" variant (Thomson, 1976), the trolley is hurtling toward the group of five people, but the switch to divert it is inoperable. The only way to save the five is to push a man who is wearing a heavy backpack off a bridge onto the track, thereby slowing the trolley enough so the five can escape, but killing the man. In contrast to the standard switch version, where causing the death of one person is but a by-product of the action necessary to save five, most subjects in the footbridge case find it morally impermissible to force the man with the backpack onto the tracks (Cushman et al., 2006; DeScioli, Gilbert, & Kurzban, 2012)—that is, when the man is used as a means to saving the five—even though the consequences are the same, and the decision to act was made knowingly and deliberately in both cases.

Such effects are found in less contrived situations, as well. Consider the real-life distinction between terrorism, in which civilian casualties are used a means to a political goal, and anticipated collateral damage, which is a by-product of war, even when the same number of civilians are knowingly killed and the same political ends are desired (say increased bargaining power in a subsequent negotiation).

The explanation again uses "higher-order beliefs" and is based on the key insight in DeScioli et al. (2011) and formalized in Dalkiran et al. (2012) and Hoffman et al. (2015): When the harm is done as a by-product, the harm is not usually anticipated.

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So even when a witness knows that the perpetrator anticipated the harm, the witness believes other witnesses will not be aware of this and will presume the harm was not anticipated by the perpetrators. For instance, suppose we observe Israel killing civilians as a by-product of a strategic raid on Hamas militants. Even if we knew Israel had intelligence that confirmed the presence of civilians, we might not be sure others were privy to this information. On the other hand, when the harm is done as a means, the harm must be anticipated, since otherwise the perpetrator would have no motive to commit the act. Why would Hamas fire rockets at civilian towns with no military presence if Hamas does not anticipate a chance of civilian casualties? Consequently, it is Nash equilibrium to punish harm done as a means but not harm done as a by-product.

Similar arguments can be made for why we find direct physical transgressions worse than indirect ones, a moral distinction relevant to, for instance, the United States' current drone policy. Cushman et al. (2006) found that subjects condemn pushing a man off a bridge (to stop a train heading toward five others) more harshly than flipping a switch that leads the man to fall through a trap door. Pushing the victim with a stick is viewed as intermediate in terms of moral wrongness. Such moral wrongness judgments are consistent with considerations of higher-order beliefs: When a man is physically pushed, any witness knows the pushing was intended, but when a man is pushed with a stick some might not realize this, and even those who realize it might suspect others will not. Even more so when a button is pressed that releases a trap door.

It is worth noting that the above argument does not depend on a specific model of punishment, as in DeScioli and Kurzban's (2009) Side-Taking Game. The above model also makes the two novel predictions enumerated above, but nevertheless captures the same basic insight. It is also worth noting the contrast between the above argument and that of Cushman et al. (2006) and Greene et al. (2009), whose models rest on ease of learning or ease of mentally simulating a situation. It is not obvious to us how those models would explain that the omission–commission and means–by-product distinctions seem to depend on priors or be unique to settings of coordinated punishment.

Why Morality Depends on Categorical Distinctions

We explain why our moral intuitions depends so much more strongly on whether a transgression occurred than on how much damage was caused. Our argument again uses coordinated punishment and higher-order beliefs: When a categorical distinction is violated, you know others know it was violated, but this is not always true for continuous variables.

Consider the longstanding norm against the use of chemical weapons. This norm recently made headlines when Bashar al-Assad was alleged to have used chemical weapons to kill about a thousand Syrian civilians, outraging world leaders who had

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been silent over his use of conventional weapons to kill over 100,000 Syrian civilians. A Reuters/Ipsos poll at the time found that only 9 % of Americans favored intervention in Syria, but 25 % supported intervention if the Syrian government forces used chemical weapons against civilians (Wroughton, 2013). In the past, the United States has abided by the norm against the use of chemical weapons even at the expense of American lives: In WWII, Franklin D. Roosevelt chose to eschew chemical weapons in Iwo Jima even though, as his advisors argued at the time, their use would have saved thousands of American lives. It might even have been more humane than the flame-throwers that were ultimately used against the Japanese ("History of Chemical Weapons," 2013). We say that the norm against chemical weapons is a categorical norm because those who abide by it consider whether a transgression was committed (did Assad use chemical weapons?), rather than focusing entirely on how much harm was done (how many civilians did Assad kill?). Other norms are similarly categorical. For instance, in the introduction to this chapter, we noted that across cultures and throughout history, the norm against murder has always been categorical: We consider whether a life was terminated, not the loss of useful life years. Likewise, discrimination (e.g., during Jim Crow) is typically based on categorical definitions of race (the "one drop rule") and not, say, the darkness of skin tone. Human rights are also categorical. A human rights violation occurs if someone is tortured or imprisoned without trial, regardless of whether it was done once or many times and regardless of whether the violation was helpful in, say, gaining crucial information about a dangerous enemy or an upcoming terror attack. We even assign rights in a categorical way to all *Homo sapiens* and not based on intelligence, sentience, ability to feel pain, etc.

Why is it that we attend to such categorical distinctions instead of paying more attention to the underlying continuous variable? We use game theory to explain this phenomenon as follows: Suppose that two players (say, the United States and France) are playing a Coordination Game in which they decide whether to punish Syria, and each wants to sanction only if the other sanctions. We assume the United States does not want to levy sanctions unless it is confident France will as well, which corresponds to an assumption on the payoffs of the game (if we reverse this assumption, it changes one line in the proof, but not the result).

We model the underlying measure of harm as a continuous variable (in our example, it is the number of civilians killed). For simplicity, we assume this variable is uniformly distributed, which means Assad is equally likely to kill any number of people. This assumption is, again, not crucial, and we will point out the line in the proof that it affects. Importantly, we assume that players do not directly observe the continuous variable, but instead receive some imperfect signal (e.g., the United States observes the body count by its surveyors).

Imagine a norm that dictates that witnesses punish if their estimate of the harm from a transgression is above some threshold (e.g., levy sanctions against Syria if the number of civilians killed is estimated to be greater than 100,000). As it turns out, this is not a Nash equilibrium. To see why, consider what happens when the United States gets a signal right at the threshold. The United States thinks there is a

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50 % chance that France's estimates are lower than its own[5] and, thus, that there is a 50 % chance that France's estimates are lower than the threshold. This further implies that the United States assesses only a 50 % chance that France levies sanctions, so the United States is not sufficiently confident that France will sanction, to make it in the United States's interest to sanction.

What we have shown so far is that for a threshold of 100,000, it is in the interest of the United States to deviate from the strategy dictated by the threshold norm when it gets a signal at the threshold. This means that 100,000 is not a viable threshold, and (since 100,000 was chosen arbitrarily) there is no Nash equilibrium in which witnesses punish if their estimate of the harm from a transgression is above some arbitrary threshold.

It should be noted that this result only requires that there are sufficiently many possibilities, not that there is in fact a continuum. Neither does it require that the distribution is uniform nor that the Coordination Game is not affected by the behavior of Assad. The only crucial assumptions are that the distribution is not too skewed and that the payoffs are not too dependent on the behavior of Assad (for details, see Dalkiran et al., 2012; Hoffman, Yoeli, & Dalkiran, 2015).

What happens if such norms are learned or evolved and subject to selection? Suppose there is a norm to attack whenever more than 100,000 civilians are killed. Players will soon realize that they should not attack unless, say, 100,100 civilians are killed. Then, players will learn not to attack when they estimate 100,200 civilians are killed and so on, indefinitely. Thus, every threshold will eventually "unravel," and no one will ever attack.[6]

Now let's consider a categorical norm, for example, the use of chemical weapons. We again model this as a random variable, though this time, the random variable can only take on two values (0 and 1), each with some probability. Again, players do not know with certainty whether the transgression occurred, but instead get a noisy signal. In our example, the signal represents France or the United States's assessment of whether Assad used chemical weapons, and there is some likelihood the assessors make mistakes: They might not detect chemical weapons when they had been used or might think they have detected chemical weapons when none had been used.

Unlike with the threshold norm, provided the likelihood of a mistaken signal is not too high, there is a Nash equilibrium where both players punish when they receive a signal that the transgression occurred. That is, the United States and France each levy sanctions if their assessors detect chemical weapons. This is because when the United States detects chemical weapons, the United States believes France

[5] This is where the assumption of a uniform distribution comes in. Had we instead assumed, for instance, that the continuous variable is normally distributed, then it would not be exactly 50–50 but would deviate slightly depending on the standard deviation and the location of the threshold. Nevertheless, the upcoming logic will still go through for most Coordination Games, i.e. any Coordination Game with risk dominance not too close to .5.

[6] As with omission, this follows from iterative elimination of strictly dominated strategies (see Hoffman et al., 2015, for details).

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likely detected them and will likely levy sanctions. So the United States's best response is to levy sanctions. Similarly, if the United States does not detect chemical weapons, it expects France did not and will not levy sanctions, so the United States is better off not levying them.

This result is useful for evaluating whether it is worthwhile to uphold a norm. The Obama administration was harshly criticized for threatening to go to war after the Assad regime used chemical weapons but not earlier, although the regime had already killed tens of thousands of civilians. The model clarifies that Obama's position was not as inconsistent as his critics had charged: The norm against chemical weapons may be worth enforcing since it is sustainable, whereas norms against civilian casualties are harder to sustain and hence might not be worthwhile to enforce.

Let's return to some more of our motivating examples. Our model can explain why we define murder categorically: It is not possible to punish differently for different amount of quality life years taken, but it is possible to punish differentially for a life taken. As with omission–commission, however, we do expect sadness or grief to depend greatly on life years lost, even if the punishment or moralistic outrage will be less sensitive. This is a prediction of the model that, as far as we know, has yet to be tested.

Similarly, the "one-drop" rule is a categorical norm, so it can be socially enforced in an apartheid society. In contrast, consider a rule that advocates giving up one's seat for someone with lighter skin. Since this is based on a threshold in a continuous variable, while it might be enforceable by a unilateral authority, it cannot be enforced by "mob rule." Other forms of discrimination, such as discriminating against the less attractive, or the less tall, or the elderly, all being continuous variables, cannot be socially enforced via coordinated punishment, and hence, we expect such discrimination to be of a different form. In particular, it will not be based not on punishing violators. For example, male CEOs might still prefer young attractive female secretaries, and taller men are more likely to be hired as CEOs, not because of coordinated rewards or punishment but because those who hire the CEOs or secretaries are likely to be satisfying their own preferences or doing what they expect will lead to higher profits.

Likewise, the number of victims tortured by a regime or the number of lives saved by torturing is continuous. Thus, a regime cannot be punished by a coordinated attack by other countries or by a coordinated rebellion by its citizens based on the number of people tortured or the paucity of reasons for such torture. But, a regime can be attacked or overthrown depending on whether a physical harm was inflicted on a citizen by the state. Hence, human rights are treated as inalienable, even in the absence of an a priori justification for this nonutilitarian norm. And why are human rights ascribed to all living *Homo sapiens*? Perhaps not because of a good logical a priori argument, but simply because violations of human rights are enforceable by coordinated punishment, but no regime can be punished for harming any "person" of less than a certain degree of consciousness.

Finally, here is one last application. The model might also explain why revolutions are often caused by categorical events, such as a new tea tax or a single, widely

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publicized self-immolation, and not a breach of a threshold in, say, the quality of life of citizens or the level of corruption. This explanation requires simply that we recognize revolutions as a coordination problem (as argued in Morris & Shin, 2002; Chwe, 2013), where each revolutionary chooses whether to revolt, and each is better off revolting only if sufficiently many others revolt.

Quirks of Altruism and the Repeated Prisoner's Dilemma with Incomplete Information

The Repeated Prisoner's Dilemma has famously been used as an explanation for the evolution of cooperation among non-kin (Axelrod & Hamilton, 1981; Dawkins, 2006; Pinker, 2003; Trivers, 1971). *In this section, we show how the same basic model can be used to explain many of the quirky features of our pro-social preferences and ideologies.*

Recall that in the Prisoner's Dilemma, each of two players simultaneously chooses whether to cooperate. Cooperation reduces a player's own payoffs by $c>0$ while increasing the other's payoffs by $b>c$. The only Nash equilibrium is for neither player to cooperate. In the Repeated Prisoner's Dilemma, the players play a string of Prisoner's Dilemmas. That is, after the players play a Prisoner's Dilemma, they learn what their opponent did and play another Prisoner's Dilemma against the same opponent with probability δ (and the game ends with probability $1-\delta$). As is well known in the evolutionary literature, there are equilibria in which players end up cooperating, provided $\delta>c/b$. In all such equilibria, cooperation is sustained because any defection by one player causes the other player to defect. This is called reciprocity. As the reader is surely familiar, there is ample evidence for the Repeated Prisoner's Dilemma as a basis for cooperation from computer simulations (e.g., Axelrod, 1984) and animal behavior (e.g., Wilkinson, 1984). The model can be extended to explain contributions to public goods if, after deciding whether to contribute to a public good, players play a Repeated Prisoner's Dilemma (see, e.g., Panchanathan & Boyd, 2004) (Fig. 5).

The key to understanding these quirks is that players often have incomplete information. For example:

1. Players do not always observe contributions. It is intuitive that, for cooperation to occur in equilibrium, contributions need to be observed with sufficiently high probability.
2. Others cannot always tell whether a player had an opportunity to contribute. For defection to be penalized, it must be the case that others can tell that a player had the opportunity to cooperate and did not (i.e. the player should not be able to hide the fact that there was an opportunity to cooperate).
3. Sometimes, there are two ways to cooperate, and one has a higher benefit, b. Then, the only way this more effective type of cooperation can be sustained in equilibrium is if others know which cooperative act is more effective.

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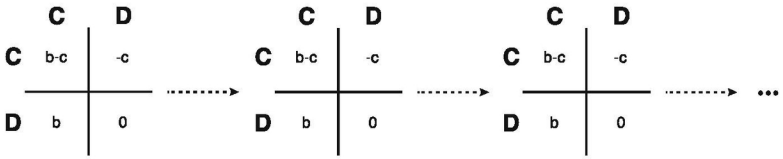

Fig. 5 The Repeated Prisoner's Dilemma. Two players play a Prisoner's Dilemma. They each observe the other's action, then, with probability δ, play another Prisoner's Dilemma against the same opponent, etc.

Technically, for the second and third point, what is needed is common knowledge that a player had an opportunity to cooperate or of the more effective means of cooperation. If observers were to know one purposely chose to defect or chose the less cooperative act, but they do not know that others know this, then observers think others will think punishment is not warranted, and observers will not punish. The argument is analogous to the discussion of higher-order beliefs in the omission–commission subsection and formalized in Dalkiran et al. (2012) and Hoffman et al. (2015).

Interpreting the Quirks of Altruism

Below we discuss some of the quirky features of altruism identified by economists and psychologists. In each case, we will argue that these features might be puzzling, but not when viewed through the lens of the above model:

Insensitivity to Effectiveness. We are surprisingly insensitive to the impact of our charitable contributions. We vote because we "want to be a part of the democratic system," or we "want to make a difference," despite the fact that our likelihood of swinging an election (even in a swing state) is smaller than our likelihood of being struck by lightning (Gelman, Silver, & Edlin, 2012). Why is our desire to "make a difference" or "be a part of the system" immune to the actual difference we are making? Our charitable contributions or volunteer efforts suffer from the same insensitivity. Why does anyone give money or volunteer time to Habitat for Humanity? The agency flies high earners who have never held a hammer halfway across the world to build houses that would be substantially more cheaply built by local experts funded by the high earners. Experimental evidence demonstrates our insensitivity: Experimental subjects are willing to pay the same amount to save 2000, 20,000, or 200,000 birds (Desvousges et al., 2010). Likewise, when donors are told their donations will be matched, tripled, or quadrupled, they donated identical amounts (Karlan & List, 2006). Why do we give so much, but do not ensure our gifts have a large impact?

The explanation follows directly from the above model: It is often the case that observers do not know which acts are effective and which are not and, certainly, this

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usually is not commonly known. Thus, they will not reward or punish based on effectiveness, and we ourselves will not attend to effectiveness in equilibrium. This explanation suggests that if we want to increase efficacy of giving, we ought to focus on making sure donors' friends and colleagues are aware of the efficacy of different options. In fact, this is perhaps more important than informing the donor of efficacy, since the donor will be motivated to uncover efficacy herself.

Magnitude of the Problem. We are surprisingly unaware of and unaffected by the magnitudes of the problems we contribute to solving. How many of those who participated in the recent ALS Ice Bucket Challenge have even the vaguest sense of the number of ALS victims? (Answer: about 1/100th the victims of heart disease.) How much happier would these individuals have been if the number of ALS victims were cut in half? Multiplied by 100? The same questions could be asked about AIDS or cleft lips. If we were actually motivated by our desire to rid the world of such afflictions as we often proclaim, then we would be happier if there were fewer afflicted individuals and less happy if there were more. But we are not even aware of these numbers, let alone affected by them. This suggests an alternative motivation than the one we proclaim.

On the other hand, if we give in order to gain social rewards, it does not matter whether the problem is large or small, provided others recognize it as a problem and the social norm is to give. If our learned or evolved preferences were drastically impacted by the magnitude of the crises, we would be sensitive to whether the problem was solved, perhaps motivating us to ensure that others solve it, which we would not get credit for, or perhaps motivating us to devote too much of our resources to solving it, beyond what we would actually get rewarded for.

Observability. There is overwhelming evidence that people give more when their gifts are observed. Much of this evidence comes from the lab, where it has been demonstrated a myriad of ways (e.g., Andreoni & Petrie, 2004; Bolton, Katok, & Ockenfels, 2005; List, Berrens, Bohara, & Kerkvliet, 2004). For instance, when participants play a public goods game in the laboratory for money, their contributions are higher when they are warned that one subject will have to announce to the room of other participants how much they contributed (List et al., 2004). However, evidence also comes from real-world settings, which find large effects in settings as diverse as blood donation (Lacetera & Macis, 2010), blackout prevention (Yoeli, Hoffman, Rand, & Nowak, 2013), and support for national parks (Alpizar, Carlsson, & Johansson-Stenman, 2008). In Switzerland, voting rates fell in small communities when voters were given the option to vote by mail (Funk, 2006), which makes it harder to tell who did not vote, even though it also makes it easier to vote. In fact, our willingness to give more when observed extends to subtle, subconscious cues of being observed: People give twice as much in dictator games when there are markings on the computer screen that vaguely represent eyes (Haley & Fessler, 2005), and they are more likely to pay for bagels in their office when the payment box has a picture of eyes above it (Bateson, Nettle, & Roberts, 2006).

These results should not surprise anyone who believes our pro-social tendencies are influenced by reputational concerns (though the magnitudes are surprisingly large).

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The effectiveness of subconscious cues of observability points to a primary role for reputations in our learned or evolved proclivities toward pro-social behavior. The large impact of subtle cues of observability, however, calls into question alternative explanations not based on reputations.

Explicit Requests. When we are asked directly for donations, we give more than if we are not asked, even though no new information is conveyed by the request. In a study of supermarket shoppers around Christmas time, researchers found that passersby were more likely to give to the Salvation Army if volunteers not only rang their bell but explicitly asked for a donation (Andreoni, Rao, & Trachtman, 2011). If our motive is to actually do good, or perhaps proximally to feel good by the act of giving, we should not be impacted by an explicit request.

However, if we evolved or learned to give in order to gain rewards or avoid punishment as described above, then we ought to be more likely to give when, if we did not give, it would be common knowledge that we had the option to give and chose not to. The explicit request makes the denial common knowledge.

It is worth emphasizing that our evolved intuition to respond to explicit asks may be (mis)applied to individual settings that lack social rewards. Imagine you are approached by a Salvation Army volunteer in front of a store in a city where you are visiting for one day only. A literal reading of the model would suggest that you should be no more likely to respond to an explicit request. But it is more realistic to expect that if your pro-social preferences were learned or evolved in repeated interactions then applied to this new setting, you would respond in a way that is not optimal for this particular setting and nonetheless give more when explicitly asked (just as our preferences for sweet and fatty foods, which evolved in an environment where food was scarce, lead us to overeat now that food is abundant).

Avoiding Situations in Which We Are Expected to Give. In the same supermarket study, researchers discovered that shoppers were going out of their way to exit the store through a side door, to avoid being asked for a contribution by the Salvation Army volunteers. In another field experiment, those who were warned in advance that a solicitor would come to the door asking for charitable donations were more likely to not be home. The researchers estimated that among those who gave, 50 % would have avoided being home if warned in advance of the solicitor's time of arrival (DellaVigna et al., 2012). In a laboratory analog, subjects who would have otherwise given money in a $10 dictator game were willing to pay a dollar to keep the remaining nine dollars and prevent the recipient from knowing that a dictator game could have been played (Dana et al. 2006). If our motive were to have an impact, we would not pay to avoid putting ourselves in a situation where we could have such an impact. Likewise, if our motive were to feel good by giving, we would not pay to avoid this feeling.

In contrast, if we evolved or learned to give in order to gain rewards or avoid punishment, then we would pay to avoid situations where we are expected to give. Again, this would be true even if, in this particular setting, we were unlikely to actually be punished.

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Norms. People are typically *conditionally cooperative*, meaning that they are willing to cooperate more when they believe others contribute more. For example, students asked to donate to a university charity gave 2.3 percentage points more when told that others had given at a rate of 64 % than when they were told giving rates were 46 % (Frey & Meier, 2004). Hotel patrons were 26 % more likely to reuse their towels when informed most others had done the same (Goldstein, Cialdini, & Griskevicius, 2008). Households have been shown to meaningfully reduce electricity consumption when told neighbors are consuming less, both in the United States (Ayres, Raseman, & Shih, 2012) and in India (Sudarshan, 2014).

Such conditional cooperation is easily explained by the game theory model: When others give, one can infer that one is expected to give and may be socially sanctioned if one does not.

Strategic Ignorance. Those at high risk of contracting a sexually transmitted disease (STD) often go untested, presumably because if they knew they had the STD, they would feel morally obliged to refrain from otherwise desirable activity that risks spreading the STD. Why is it more reproachable to knowingly put a sexual partner at risk when one knows one has the STD than to knowingly put a sexual partner at risk by not getting tested? There is evidence that we sometimes pursue *strategic ignorance* and avoid information about the negative consequences of our decisions to others. When subjects are shown two options, one that is better for themselves but worse for their partners and one that is worse for themselves but better for their partners, many choose the option that is better for their partners. But, when subjects must first press a button (at no cost) to reveal which option is better for their partners, they choose to remain ignorant and simply select the option that is best for themselves (Dana, Weber, & Kuang, 2007).

This quirk of our moral system is again easy to explain with the above model. Typically, information about how one's actions affect others is hard to obtain, so people cannot be blamed for not having such information. When one can get such information easily, others may not know that it is easy to obtain and will not punish anyone who does not have the information. For example, although it is trivially easy to look up charities' financial ratings on websites like charitynavigator.org, few people know this and *could* negatively judge those that donate without first checking such websites. And even when others know that one can get this information easily, they might suspect that others do not know this, and so avoid punishing, since others won't expect punishment. To summarize, strategic ignorance prevents common knowledge of a violation and so is likely to go unpunished. We again emphasize that we will be lenient of strategic ignorance, even when punishment is not literally an option.

Norm of Reciprocity. We feel compelled to reciprocate favors, even if we know that the favors were done merely to elicit reciprocation and even if the favor asked in return is larger than the initial one granted (Cialdini 2001). For instance, members of Hare Krishna successfully collect donations by handing out flowers to disembarking passengers at airports, even though passengers want nothing to do with the flowers: They walk just a few feet before discarding them in the nearest bin.

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Psychologists and economists sometimes take this "norm" as given, without asking where it comes from, and a naive reading of Trivers would lead one to think that we should be sensitive to the magnitude of the initial favor and whether it is manipulative.

However, according to the above model, reciprocity is the Nash equilibrium, even if the favors are not evenly matched or manipulative, since, in equilibrium, we are neither sensitive to such quantitative distinctions nor to whether the initial reciprocity was manipulative, unless these facts are commonly known.

Self-Image Concerns. People sometimes play mental tricks in order to appear *to themselves* as pro-social. For example, in an experiment, subjects will voluntarily take on a boring task to save another subject from doing it, but if given the option of privately flipping a coin to determine who gets the task, they often flip—and flip, and flip again—until the "coin" assigns the task to the other subject (Batson, Kobrynowicz, Dinnerstein, Kampf, & Wilson, 1997). Why would we be able to fool ourselves and not, say, recognize that we are gaming the coin flip? Why do we care what we think of ourselves at all? Are there any constraints on how we will deceive ourselves?

Such self-image considerations can be explained by noting that our self-image can act as a simple proxy, albeit an imperfect one, for what others think of us, and also that we are more convincing to others when we believe something ourselves (Kurzban, 2012; Trivers, 2011). This explanation suggests that the ways we deceive ourselves correspond to quirks described throughout this section—for example, we will absolve ourselves of remaining strategically ignorant even when it is easy not to, or be convinced that we have done good by voting, even if we cannot swing an election.

Framing Effects. Whether we contribute is highly dependent on the details of the experiment, such as the choice set (List, 2007) and the labels for the different choices (Ross & Ward, 1996; Roth, 1995). Such findings are often taken as evidence that social preferences cannot be properly measured in the lab (Levitt & List, 2007).

We believe a more fruitful interpretation is simply that the frame influences whether the laboratory experiment "turns on" our pro-social preferences, perhaps by simulating a situation where cooperation is expected (Levitt & List, 2007).

One-Shot Anonymous Giving: We give in anonymous, one-shot settings, such as dictator games. We also sacrifice for others in the real world when there is no chance of reciprocation: Heroes jump on grenades to save their fellow soldiers or block the door to a classroom with their bodies to prevent a school shooter from entering (Rand & Epstein, 2014). This is often seen as evidence for a role of group selection (Fehr & Fischbacher, 2003).

However, an alternate explanation is that we do not consider the likelihood of reciprocation (Hoffman et al., 2015), as described above. To explain the laboratory evidence, there are two more possibilities. First, subjects may believe there is some chance their identity will be revealed and feel the costs of being revealed as selfish are greater than the gains from the experiment (Delton, Krasnow, Cosmides, & Tooby, 2011). Second, we again emphasize that learned or evolved preferences and ideologies are expected to be applied even in novel settings to which they are not optimized.

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Conclusion

In this chapter we have showed that a single approach–game theory, with the help of evolution and learning–can explain many of our moral intuitions and ideologies. We now discuss two implications.

Group Selection. Our chapter relates to the debate on group selection, whereby group level competition and reproduction is supposed to occasionally cause individuals to evolve to sacrifice their own payoffs to benefit the group (e.g., Wilson, 2006). One of the primary pieces of evidence cited in support of group selection is the existence of human cooperation and morality (Fehr & Fischbacher, 2003; Fehr, Fischbacher, & Gächter, 2002; Gintis, Bowles, Boyd, & Fehr, 2003; Haidt, 2012; Wilson, 2010, 2012), in particular: giving in one-shot anonymous laboratory experiments, intuitively sacrificing one's life for the group (jumping on the grenade), and contributions to public goods or charity. However, we have reviewed an alternative explanation for these phenomena that does not rest on group selection. It also yields predictions about these phenomena that group selection does not, such as that people are more likely to cooperate when they are being observed and there is variance in the cost of cooperation. The approach described here also explains other phenomena, such as categorical norms and ineffective altruism. These lead to social welfare losses, which is suboptimal from the group's perspective. The categorical norm against murder, for example, leads to enormous waste when keeping alive, sometimes for years, those who have virtually no chance of a future productive life.

Admittedly, despite their inefficiencies, these moral intuitions do not rule out group selection, since group selection can be weak relative to individual selection. But it does provide a powerful argument that group selection is unnecessary for explaining many interesting aspects of human morality. It also suggests that group selection is, indeed, at most, weak. One example that makes this especially clear is discrete norms. Recall that we argued that continuous norms are not sustainable because individuals benefit by deviating around the threshold. Notice that this benefit is small, since the likelihood that signals are right around the threshold is low. Group selection could easily overwhelm the benefit one would get from deviating from this Nash equilibrium, suggesting group selection is weak (i.e. there are few group-level reproductive events, high migration rates, high rates of "mutation" in the form of experimentation among individuals, etc.).

Logical Justification of Moral Intuitions. In each of the applications above, we explained moral intuitions without referring to existing a priori logical justifications by philosophers or others. Our explanation for our sense of rights does not rely on Locke's "state of nature." No argument we gave rests on God as an orderly designer, on Platonic ideals, on Kant's concepts of autonomy and humanity, etc. What does this mean for these a priori justifications? It suggests that they are not the source of our morality and are, instead, post hoc justifications of our intuitions (Haidt, 2012).

To see what we mean, consider the following analogy. One might wonder why we find paintings and sculptures of voluptuous women beautiful. Before the

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development of sexual selection theory, one might have argued that perfect spheres are some kind of Platonic solid, and inherently desirable, or that curvy hips yield golden ratios. But with our current understanding of sexual selection, we recognize that our sense of beauty has evolved and that there is no platonic sense of beauty outside of that shaped by sexual selection. Any argument about perfect spheres is unparsimonious and likely flawed. Without the help of evolution and game theory, did philosophers conjure the moral equivalents of perfect spheres and golden ratios? The state of nature, the orderly designer, Platonic ideals, autonomy, and humanity, etc.—perhaps these arguments are also unfounded and unnecessary.

References

Alpizar, F., Carlsson, F., & Johansson-Stenman, O. (2008). Anonymity, reciprocity, and conformity: Evidence from voluntary contributions to a national park in Costa Rica. *Journal of Public Economics, 92*(5), 1047–1060.

Andreoni, J., & Petrie, R. (2004). Public goods experiments without confidentiality: A glimpse into fund-raising. *Journal of Public Economics, 88*(7), 1605–1623.

Andreoni, J. (1990). Impure altruism and donations to public goods: A theory of warm-glow giving. *The Economic Journal, 100*, 464–477.

Andreoni, J., Rao, J. M., & Trachtman, H. (2011). *Avoiding the ask: A field experiment on altruism, empathy, and charitable giving*. Technical report, National Bureau of Economic Research.

Axelrod, R. M. (1984). *The evolution of cooperation*. New York: Basic Books.

Axelrod, R., & Hamilton, W. D. (1981). The evolution of cooperation. *Science, 211*(4489), 1390–1396.

Ayres, I., Raseman, S., & Shih, A. (2012). Evidence from two large field experiments that peer comparison feedback can reduce residential energy usage. *Journal of Law, Economics, and Organization*, 2–20.

Bateson, M., Nettle, D., & Roberts, G. (2006). Cues of being watched enhance cooperation in a real-world setting. *Biology Letters, 2*(3), 412–414.

Batson, C. D. (2014). *The altruism question: Toward a social-psychological answer*. Hillside, NJ: Psychology Press.

Batson, C. D., Kobrynowicz, D., Dinnerstein, J. L., Kampf, H. C., & Wilson, A. D. (1997). In a very different voice: Unmasking moral hypocrisy. *Journal of Personality and Social Psychology, 72*(6), 1335.

Bolton, G. E., Katok, E., & Ockenfels, A. (2005). Cooperation among strangers with limited information about reputation. *Journal of Public Economics, 89*(8), 1457–1468.

Cain, D., Dana, J., & Newman, G. (2014). *Giving vs. giving in*. Yale University Working Paper.

Camerer, C. (2003). *Behavioral game theory: Experiments in strategic interaction*. Princeton, NJ: Princeton University Press.

Chammah, A. M., & Rapoport, A. (1965). *Prisoner's dilemma; a study in conflict and cooperation*. Ann Arbor, MI: University of Michigan.

Chwe, M. (2013). *Rational ritual: Culture, coordination, and common knowledge*. Princeton, NJ: Princeton University Press.

Cone v. West Virginia Pulp & Paper Co., 330 U.S. 212, 67 S. Ct. 752, 91 L. Ed. 849 (1947).

Critcher, C. R., Inbar, Y., & Pizarro, D. A. (2013). How quick decisions illuminate moral character. *Social Psychological and Personality Science, 4*(3), 308–315.

Cushman, F., Young, L., & Hauser, M. (2006). The role of conscious reasoning and intuition in moral judgment testing three principles of harm. *Psychological Science, 17*(12), 1082–1089.

HOUSE_OVERSIGHT_015525

Dalkiran, N. A., Hoffman, M., Paturi, R., Ricketts, D., & Vattani, A. (2012). Common knowledge and state-dependent equilibria. In *Algorithmic game theory* (pp. 84–95). New York: Springer.

Dana, J., Cain, D. M., & Dawes, R. M. (2006). What you don't know won't hurt me: Costly (but quiet) exit in dictator games. *Organizational Behavior and Human Decision Processes, 100*(2), 193–201.

Dana, J., Weber, R. A., & Kuang, J. X. (2007). Exploiting moral wiggle room: Experiments demonstrating an illusory preference for fairness. *Economic Theory, 33*(1), 67–80.

Davies, N. B. (1978). Territorial defense in the speckled wood butterfly (pararge aegeria): The resident always wins. *Animal Behaviour, 26*, 138–147.

Dawkins, R. (2006). *The selfish gene*. Oxford, UK: Oxford University Press.

DellaVigna, S., List, J. A., & Malmendier, U. (2012). Testing for altruism and social pressure in charitable giving. *The Quarterly Journal of Economics, 127*(1), 1–56.

Delton, A. W., Krasnow, M. M., Cosmides, L., & Tooby, J. (2011). Evolution of direct reciprocity under uncertainty can explain human generosity in one-shot encounters. *Proceedings of the National Academy of Sciences, 108*(32), 13335–13340.

DeScioli, P., Bruening, R., & Kurzban, R. (2011). The omission effect in moral cognition: Toward a functional explanation. *Evolution and Human Behavior, 32*(3), 204–215.

DeScioli, P., Gilbert, S. S., & Kurzban, R. (2012). Indelible victims and persistent punishers in moral cognition. *Psychological Inquiry, 23*(2), 143–149.

DeScioli, P., & Wilson, B. J. (2011). The territorial foundations of human property. *Evolution and Human Behavior, 32*(5), 297–304.

DeScioli, P., & Kurzban, R. (2009). Mysteries of morality. *Cognition, 112*(2), 281–299.

Descioli, P., & Karpoff, R. (2014). *People's judgments about classic property law cases*. Brandeis University Working Paper.

Desvousges, W. H., Johnson, F. R., Dunford, R. W., Boyle, K. J., Hudson, S. P., Wilson, K. N., et al. (2010). *Measuring nonuse damages using contingent valuation: An experimental evaluation of accuracy*. Research Triangle Park, NC: RTI Press.

Epley, N., Keysar, B., Van Boven, L., & Gilovich, T. (2004). Perspective taking as egocentric anchoring and adjustment. *Journal of Personality and Social Psychology, 87*(3), 327.

Fehr, E., & Fischbacher, U. (2003). The nature of human altruism. *Nature, 425*(6960), 785–791.

Fehr, E., Fischbacher, U., & Gächter, S. (2002). Strong reciprocity, human cooperation, and the enforcement of social norms. *Human Nature, 13*(1), 1–25.

Fisher, R. A. (1958). *The genetic theory of natural selection*. Mineola, NY: Dover.

Frank, R. H. (1988). *Passions within reason: The strategic role of the emotions*. New York: WW Norton & Co.

Frey, B. S., & Meier, S. (2004). Social comparisons and pro-social behavior: Testing "conditional cooperation" in a field experiment. *American Economic Review, 94*, 1717–1722.

Funk, P. (2006). Modern voting tools, social incentives and voter turnout: Theory and evidence. In *Annual Meeting of the American Economic Association*, Chicago, IL.

Gelman, A., Silver, N., & Edlin, A. (2012). What is the probability your vote will make a difference? *Economic Inquiry, 50*(2), 321–326.

Gintis, H. (2007). The evolution of private property. *Journal of Economic Behavior & Organization, 64*(1), 1–16.

Gintis, H., Bowles, S., Boyd, R., & Fehr, E. (2003). Explaining altruistic behavior in humans. *Evolution and Human Behavior, 24*(3), 153–172.

Goldstein, N. J., Cialdini, R. B., & Griskevicius, V. (2008). A room with a view-point: Using social norms to motivate environmental conservation in hotels. *Journal of Consumer Research, 35*(3), 472–482.

Greene, J. D., Cushman, F. A., Stewart, L. E., Lowenberg, K., Nystrom, L. E., & Cohen, J. D. (2009). Pushing moral buttons: The interaction between personal force and intention in moral judgment. *Cognition, 111*(3), 364–371.

Haidt, J. (2012). *The righteous mind: Why good people are divided by politics and religion*. New York: Vintage.

Haley, K. J., & Fessler, D. M. (2005). Nobody's watching? Subtle cues affect generosity in an anonymous economic game. *Evolution and Human Behavior, 26*.

HOUSE_OVERSIGHT_015526

Hedden, T., & Zhang, J. (2002). What do you think I think you think? Strategic reasoning in matrix games. *Cognition, 85*(1), 1–36.

Hoffman, M., Yoeli, E., & Nowak, M. A. (2015). Cooperate without looking: Why we care what people think and not just what they do. *Proceedings of the National Academy of Sciences, 112*(6), 1727–1732.

Hoffman, M., Yoeli, E., & Dalkiran, A. (2015). *Social applications of common knowledge*. Harvard University Working Paper.

Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1990). Experimental tests of the endowment effect and the Coase theorem. *Journal of Political Economy, 98*, 1325–1348.

Kant, I. (1997/1787). Groundwork of the metaphysics of morals (1785). *Practical Philosophy, 108*.

Karlan, D., & List, J. A. (2006). *Does price matter in charitable giving? Evidence from a large-scale natural field experiment*. Technical report, National Bureau of Economic Research.

Kurzban, R. (2012). *Why everyone (else) is a hypocrite: Evolution and the modular mind.* Princeton, NJ: Princeton University Press.

Lacetera, N., & Macis, M. (2010). Social image concerns and prosocial behavior: Field evidence from a nonlinear incentive scheme. *Journal of Economic Behavior & Organization, 76*(2), 225–237.

Levitt, S. D., & List, J. A. (2007). What do laboratory experiments measuring social preferences reveal about the real world? *The Journal of Economic Perspectives, 21*, 153–174.

List, J. A. (2007). On the interpretation of giving in dictator games. *Journal of Political Economy, 115*(3), 482–493.

List, J. A., Berrens, R. P., Bohara, A. K., & Kerkvliet, J. (2004). Examining the role of social isolation on stated preferences. *American Economic Review, 94*, 741–752.

Locke, J. (1988/1688). *Locke: Two treatises of government student edition*. Cambridge, UK: Cambridge University Press.

Mankiw, N. G. (2007). *Principles of economics*. Thomson Learning.

Milgrom, P., & Weber, R. J. (1982). The value of information in a sealed-bid auction. *Journal of Mathematical Economics, 10*(1), 105–114.

Morris, S., & Shin, H. S. (2002). Social value of public information. *The American Economic Review, 92*(5), 1521–1534.

Myerson, R. B. (2004). Justice, institutions, and multiple equilibria. *Chicago Journal of International Law, 5*, 91.

Neuwirth, R. (2005). *Shadow cities: A billion squatters, a new urban world*. New York: Routledge.

Nowak, M. A. (2006). *Evolutionary dynamics: Exploring the equations of life*. Cambridge, MA: Harvard University Press.

Panchanathan, K., & Boyd, R. (2004). Indirect reciprocity can stabilize cooperation without the second-order free rider problem. *Nature, 432*(7016), 499–502.

Pinker, S. (2003). *The blank slate: The modern denial of human nature*. UK: Penguin.

Pinker, S., Nowak, M. A., & Lee, J. J. (2008). The logic of indirect speech. *Proceedings of the National Academy of Sciences, 105*(3), 833–838.

Rand, D. G., & Epstein, Z. G. (2014). *Risking your life without a second thought: Intuitive decision-making and extreme altruism*. Available at SSRN 2424036.

Ross, L., & Ward, A. (1996). Naive realism: Implications for social conflict and misunderstanding. In T. Brown, E. Reed, & E. Turiel (Eds.), *Values and knowledge* (pp. 103–135).

Roth, A. E. (1995). Bargaining experiments. In J. H. Kagel & E. R. Alvin (Eds.), *The handbook of experimental economics* (pp. 253–342). Princeton, NJ: Princeton University Press.

Sigg, H., & Falett, J. (1985). Experiments on respect of possession and property in hamadryas baboons (*Papio hamadryas*). *Animal Behaviour, 33*(3), 978–984.

Smith, J. M., & Price, G. (1973). The logic of animal conflict. *Nature, 246*, 15.

Sosis, R., & Alcorta, C. (2003). Signaling, solidarity, and the sacred: The evolution of religious behavior. *Evolutionary Anthropology: Issues, News, and Reviews, 12*(6), 264–274.

Spranca, M., Minsk, E., & Baron, J. (1991). Omission and commission in judgment and choice. *Journal of Experimental Social Psychology, 27*(1), 76–105.

HOUSE_OVERSIGHT_015527

Sudarshan, A. (2014). *Nudges in the marketplace: Using peer comparisons and incentives to reduce household electricity consumption*. Technical report, Harvard University Working Paper.

Thaler, R. (1980). Toward a positive theory of consumer choice. *Journal of Economic Behavior & Organization, 1*(1), 39–60.

Thomson, J. J. (1976). Killing, letting die, and the trolley problem. *The Monist, 59*(2), 204–217.

Tirole, J. (1988). *The theory of industrial organization*. Cambridge, MA: MIT Press.

Trivers, R. (2011). *The folly of fools: The logic of deceit and self-deception in human life*. New York: Basic Books.

Trivers, R. L. (1971). The evolution of reciprocal altruism. *Quarterly Review of Biology, 46*, 35–57.

Trivers, R. L. (1974). Parent-offspring conflict. *American Zoologist, 14*(1), 249–264.

Wilkinson, G. S. (1984). Reciprocal food sharing in the vampire bat. *Nature, 308*(5955), 181–184.

Wilson, D. S. (2010). *Darwin's cathedral: Evolution, religion, and the nature of society*. Chicago: University of Chicago Press.

Wilson, E. O. (2012). *The social conquest of earth*. New York: WW Norton & Company.

Wilson, D. S. (2006). Human groups as adaptive units: Toward a permanent consensus. In P. Carruthers, S. Laurence, & S. Stich (Eds.), *The innate mind: Culture and cognition*. Oxford, UK: Oxford University Press.

Winter, E. (2014). *Feeling smart: Why our emotions are more rational than we think*. Public Books.

Wroughton, L. (2013). As Syria War Escalates, Americans Cool to U.S. Intervention: Reuter/Ipsos Poll. *Reuters*, August 24, 2013. Accessed at http://www.reuters.com/article/2013/08/25/us-syria-crisis-usa-poll-idUSBRE97O00E20130825 on 12 March 2015.

Yoeli, E., Hoffman, M., Rand, D. G., & Nowak, M. A. (2013). Powering up with indirect reciprocity in a large-scale field experiment. *Proceedings of the National Academy of Sciences, 110*(Suppl. 2), 10424–10429.

Zahavi, A. (1975). Mate selection: A selection for a handicap. *Journal of Theoretical Biology, 53*(1), 205–214.

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'millionaire's house' for a day or two, before returning with cash.

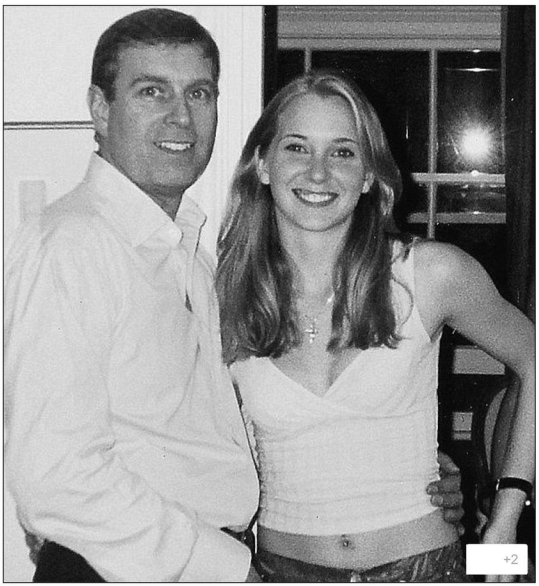
He did say that she tried to get out of the sex business, but was dragged back in.

Last month it was revealed Roberts accused two male acquaintances she was raped, bringing her credibility into question.

Roberts' lawyers says the latest allegations do not contend the fact she was used for underage sex.

Attorney Sigrid McCawleysaid : 'To say that our client acquiesced in this abuse, or that the abuse was OK because she was paid for it — leaves out the fact that this is why we have laws in the United States to protect minor children who are groomed and sexually trafficked by adults.'

Epstein served 13 months in a Florida prison after pleading guilty in 2008 to soliciting a minor for prostitution.



Allegations: The 31-year-old is currently in the midst of a lawsuit claiming she was recruited to join Epstein's harem of underage women in 1999, naming Prince Andrew and attorney Alan Dershowitz as two of the men she was made to 'service'

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The scandal resurfaced in January when Roberts named Prince Andrew in a lawsuit, accusing him of using her for underage sex.

According to court records connected with Roberts' current lawsuit, she maintains that she was recruited to join Epstein's harem in 1999 by his friend, the socialite Ghislaine Maxwell.

She says during the three years she worked for Epstein, she was made to entertain his friends and named Prince Andrew and Dershowitz as two men she had sex with.

Both men have denied having sex with Roberts, and Dershowitz is trying to get his name removed from the suit, claiming Roberts made the entire story up.

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Christina Milian shows off her curves and pert derriere in a skimpy animal print bikini while cavorting with a mystery male in Miami
Barely there two-piece

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EXHIBIT G

United States District Court
Southern District of New York

VIRGINIA L. GIUFFRE,

Plaintiff, CASE NO:_____

v.

GHISLAINE MAXWELL,

Defendant.

_____/

COMPLAINT

Boies Schiller & Flexner LLP
575 Lexington Avenue
New York, NY 10022
(212) 446-2300

HOUSE_OVERSIGHT_015531

Plaintiff, VIRGINIA L. GIUFFRE, formerly known as Virginia Roberts ("Giuffre"), for her Complaint against Defendant, GHISLAINE MAXWELL ("Maxwell"), avers upon personal knowledge as to her own acts and status and otherwise upon information and belief:

NATURE OF THE ACTION

1. This suit arises out of Defendant Maxwell's defamatory statements against Plaintiff Giuffre. As described below, Giuffre was a victim of sexual trafficking and abuse while she was a minor child. Defendant Maxwell not only facilitated that sexual abuse but, most recently, wrongfully subjected Giuffre to public ridicule, contempt and disgrace by, among other things, calling Giuffre a liar in published statements with the malicious intent of discrediting and further damaging Giuffre worldwide.

JURISDICTION AND VENUE

2. This is an action for damages in an amount in excess of the minimum jurisdictional limits of this Court.

3. This Court has jurisdiction over this dispute pursuant to 28 U.S.C. §1332 (diversity jurisdiction) as Giuffre and Maxwell are citizens of different states and the amount in controversy exceeds seventy-five thousand ($75,000), exclusive of interest and costs.

4. This Court has personal jurisdiction over Maxwell. Maxwell resides in New York City, and this action arose, and defamatory statements were made, within the Southern District of New York.

5. Venue is proper in this Court as the cause of action arose within the jurisdiction of this Court.

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PARTIES

6. Plaintiff Giuffre is an individual who is a citizen of the State of Colorado.

7. Defendant Maxwell, who is domiciled in the Southern District of New York, is not a citizen of the state of Colorado.

FACTUAL ALLEGATIONS

8. Virginia Giuffre became a victim of sex trafficking and repeated sexual abuse after being recruited by Ghislaine Maxwell and Jeffrey Epstein when Giuffre was under the age of eighteen.

9. Between 1999 and 2002, with the assistance and participation of Maxwell, Epstein sexually abused Giuffre at numerous locations including his mansions in West Palm Beach, Florida, and in this District. Between 2001 and 2007, with the assistance of numerous co-conspirators, Epstein abused more than thirty (30) minor underage girls, a fact confirmed by state and federal law enforcement.

10. As part of their sex trafficking efforts, Epstein and Maxwell intimidated Giuffre into remaining silent about what had happened to her.

11. In September 2007, Epstein entered into a Non-Prosecution Agreement ("NPA") that barred his prosecution for numerous federal sex crimes in the Southern District of Florida.

12. In the NPA, the United States additionally agreed that it would not institute any federal criminal charges against any potential co-conspirators of Epstein.

13. As a co-conspirator of Epstein, Maxwell was consequently granted immunity in the Southern District of Florida through the NPA.

14. Epstein ultimately pled guilty to procuring a minor for prostitution, and is now a registered sex offender.

15. Rather than confer with the victims about the NPA, the U.S. Attorney's Office and Epstein agreed to a "confidentiality" provision in the Agreement barring its disclosure to anyone—including Epstein's victims. As a consequence, the victims were not told about the NPA.

16. On July 7, 2008, a young woman identified as Jane Doe No. 1, one of Jeffrey Epstein's victims (other than Giuffre), filed a petition to enforce her rights under the Crime Victims' Rights Act ("CVRA"), 18 U.S.C. ¶ 3771, alleging that the Government failed to provide her the rights promised in the CVRA with regard to the plea arrangement with Epstein. The litigation remains ongoing.

17. On or about May 4, 2009, Virginia Giuffre—identified then as Jane Doe No. 102—filed a complaint against Jeffrey Epstein in the United States District Court for the Southern District of Florida. The complaint included allegations made by Giuffre that pertained to Maxwell.

18. In pertinent part, the Jane Doe No. 102 complaint described in detail how Maxwell recruited Giuffre (who was then a minor girl) to become a victim of sex trafficking by introducing Giuffre to Jeffrey Epstein. With the assistance of Maxwell, Epstein was able to sexually abuse Giuffre for years until Giuffre eventually escaped.

19. The Jane Doe No. 102 complaint contained the first public allegations made on behalf of Giuffre regarding Maxwell.

20. As civil litigation against Epstein moved forward on behalf of Giuffre and many other similarly-situated victims, Maxwell was served with a subpoena for deposition. Her testimony was sought concerning her personal knowledge and role in Epstein's abuse of Giuffre and others.

21. To avoid her deposition, Maxwell claimed that her mother fell deathly ill and that consequently she was leaving the United States for London with no plans of ever returning. In fact, however, within weeks of using that excuse to avoid testifying, Maxwell had returned to New York.

22. In 2011, two FBI agents located Giuffre in Australia—where she had been hiding from Epstein and Maxwell for several years—and arranged to meet with her at the U.S. Consulate in Sidney. Giuffre provided truthful and accurate information to the FBI about Epstein and Maxwell's sexual abuse.

23. Ultimately, as a mother and one of Epstein's many victims, Giuffre believed that she should speak out about her sexual abuse experiences in hopes of helping others who had also suffered from sexual trafficking and abuse.

24. On December 23, 2014, Giuffre incorporated an organization called Victims Refuse Silence, Inc., a Florida not-for-profit corporation.

25. Giuffre intended Victims Refuse Silence to change and improve the fight against sexual abuse and human trafficking. The goal of her organization was, and continues to be, to help survivors surmount the shame, silence, and intimidation typically experienced by victims of sexual abuse. Giuffre has now dedicated her professional life to helping victims of sex trafficking.

26. On December 30, 2014, Giuffre moved to join the on-going litigation previously filed by Jane Doe 1 in the Southern District of Florida challenging Epstein's non-prosecution agreement by filing her own joinder motion.

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27. Giuffre's motion described Maxwell's role as one of the main women who Epstein used to procure under-aged girls for sexual activities and a primary co-conspirator and participant in his sexual abuse and sex trafficking scheme.

28. In January, 2015, Maxwell undertook a concerted and malicious campaign to discredit Giuffre and to so damage her reputation that Giuffre's factual reporting of what had happened to her would not be credited.

29. As part of Maxwell's campaign she directed her agent, Ross Gow, to attack Giuffre's honesty and truthfulness and to accuse Giuffre of lying.

30. On or about January 3, 2015, speaking through her authorized agent, Maxwell issued an additional false statement to the media and public designed to maliciously discredit Giuffre. That statement contained the following deliberate falsehoods:

(a) That Giuffre's sworn allegations "**against Ghislaine Maxwell are untrue.**"

(b) That the allegations have been "shown to be untrue."

(c) That Giuffre's "**claims are <u>obvious lies</u>.**"

31. Maxwell's January 3, 2015, statement incorporated by reference "Ghislaine Maxwell's original response to the lies and defamatory claims remains the same," an earlier statement that had falsely described Giuffre's factual assertions as "entirely false" and "entirely untrue."

32. Maxwell made the same false and defamatory statements as set forth above, in the Southern District of New York and elsewhere in a deliberate effort to maliciously discredit Giuffre and silence her efforts to expose sex crimes committed around the world by Maxwell, Epstein, and other powerful persons. Maxwell did so with the purpose and effect of having

HOUSE_OVERSIGHT_015536

others repeat such false and defamatory statements and thereby further damaged Giuffre's reputation.

33. Maxwell made her statements to discredit Giuffre in close consultation with Epstein. Maxwell made her statements knowing full well they were false.

34. Maxwell made her statements maliciously as part of an effort to conceal sex trafficking crimes committed around the world by Maxwell, Epstein and other powerful persons.

35. Maxwell intended her false and defamatory statements set out above to be broadcast around the world and to intimidate and silence Giuffre from making further efforts to expose sex crimes committed by Maxwell, Epstein, and other powerful persons.

36. Maxwell intended her false statements to be specific statements of fact, including a statement that she had not recruited an underage Giuffre for Epstein's abuse. Maxwell's false statements were broadcast around the world and were reasonably understood by those who heard them to be specific factual claims by Maxwell that she had not helped Epstein recruit or sexually abuse Giuffre and that Giuffre was a liar.

37. On or about January 4, 2015, Maxwell continued her campaign to falsely and maliciously discredit Giuffre. When a reporter on a Manhattan street asked Maxwell about Giuffre's allegations against Maxwell, she responded by saying: "I am referring to the statement that we made." *The New York Daily News* published a video of this response by Maxwell indicating that she made her false statements on East 65th Street in Manhattan, New York, within the Southern District of New York.

COUNT I
DEFAMATION

1. Plaintiff Giuffre re-alleges paragraphs 1 - 37 as if the same were fully set forth herein. Maxwell made her false and defamatory statements deliberately and maliciously with the intent to intimidate, discredit and defame Giuffre.

2. In January 2015, and thereafter, Maxwell intentionally and maliciously released to the press her false statements about Giuffre in an attempt to destroy Giuffre's reputation and cause her to lose all credibility in her efforts to help victims of sex trafficking.

3. Maxwell additionally released to the press her false statements with knowledge that her words would dilute, discredit and neutralize Giuffre's public and private messages to sexual abuse victims and ultimately prevent Giuffre from effectively providing assistance and advocacy on behalf of other victims of sex trafficking, or to expose her abusers.

4. Using her role as a powerful figure with powerful friends, Maxwell's statements were published internationally for the malicious purpose of further damaging a sexual abuse and sexual trafficking victim; to destroy Giuffre's reputation and credibility; to cause the world to disbelieve Giuffre; and to destroy Giuffre's efforts to use her experience to help others suffering as sex trafficking victims.

5. Maxwell, personally and through her authorized agent, Ross Gow, intentionally and maliciously made false and damaging statements of fact concerning Giuffre, as detailed above, in the Southern District of New York and elsewhere.

6. The false statements made by Gow were all made by him as Maxwell's authorized agent and were made with direct and actual authority from Maxwell as the principal.

7. The false statements that Maxwell made personally, and through her authorized agent Gow, not only called Giuffre's truthfulness and integrity into question, but also exposed Giuffre to public hatred, contempt, ridicule, and disgrace.

8. Maxwell made her false statements knowing full well that they were completely false. Accordingly, she made her statements with actual and deliberate malice, the highest degree of awareness of falsity.

9. Maxwell's false statements constitute libel, as she knew that they were going to be transmitted in writing, widely disseminated on the internet and in print. Maxwell intended her false statements to be published by newspaper and other media outlets internationally, and they were, in fact, published globally, including within the Southern District of New York.

10. Maxwell's false statements constitute libel per se inasmuch as they exposed Giuffre to public contempt, ridicule, aversion, and disgrace, and induced an evil opinion of her in the minds of right-thinking persons.

11. Maxwell's false statements also constitute libel per se inasmuch as they tended to injure Giuffre in her professional capacity as the president of a non-profit corporation designed to help victims of sex trafficking, and inasmuch as they destroyed her credibility and reputation among members of the community that seeks her help and that she seeks to serve.

12. Maxwell's false statements directly stated and also implied that in speaking out against sex trafficking Giuffre acted with fraud, dishonesty, and unfitness for the task. Maxwell's false statements directly and indirectly indicate that Giuffre lied about being recruited by Maxwell and sexually abused by Epstein and Maxwell. Maxwell's false statements were reasonably understood by many persons who read her statements as conveying that specific intention and meaning.

HOUSE_OVERSIGHT_015539

13. Maxwell's false statements were reasonably understood by many persons who read those statements as making specific factual claims that Giuffre was lying about specific facts.

14. Maxwell specifically directed her false statements at Giuffre's true public description of factual events, and many persons who read Maxwell's statements reasonably understood that those statements referred directly to Giuffre's account of her life as a young teenager with Maxwell and Epstein.

15. Maxwell intended her false statements to be widely published and disseminated on television, through newspapers, by word of mouth and on the internet. As intended by Maxwell, her statements were published and disseminated around the world.

16. Maxwell coordinated her false statements with other media efforts made by Epstein and other powerful persons acting as Epstein's representatives and surrogates. Maxwell made and coordinated her statements in the Southern District of New York and elsewhere with the specific intent to amplify the defamatory effect those statements would have on Giuffre's reputation and credibility.

17. Maxwell made her false statements both directly and through agents who, with her general and specific authorization, adopted, distributed, and published the false statements on Maxwell's behalf. In addition, Maxwell and her authorized agents made false statements in reckless disregard of their truth or falsity and with malicious intent to destroy Giuffre's reputation and credibility; to prevent her from further disseminating her life story; and to cause persons hearing or reading Giuffre's descriptions of truthful facts to disbelieve her entirely. Maxwell made her false statements wantonly and with the specific intent to maliciously damage Giuffre's good name and reputation in a way that would destroy her efforts to administer her

HOUSE_OVERSIGHT_015540

non-profit foundation, or share her life story, and thereby help others who have suffered from sexual abuse.

18. As a result of Maxwell's campaign to spread false, discrediting and defamatory statements about Giuffre, Giuffre suffered substantial damages in an amount to be proven at trial.

19. Maxwell's false statements have caused, and continue to cause, Giuffre economic damage, psychological pain and suffering, mental anguish and emotional distress, and other direct and consequential damages and losses.

20. Maxwell's campaign to spread her false statements internationally was unusual and particularly egregious conduct. Maxwell sexually abused Giuffre and helped Epstein to sexually abuse Giuffre, and then, in order to avoid having these crimes discovered, Maxwell wantonly and maliciously set out to falsely accuse, defame, and discredit Giuffre. In so doing, Maxwell's efforts constituted a public wrong by deterring, damaging, and setting back Giuffre's efforts to help victims of sex trafficking. Accordingly, this is a case in which exemplary and punitive damages are appropriate.

21. Punitive and exemplary damages are necessary in this case to deter Maxwell and others from wantonly and maliciously using a campaign of lies to discredit Giuffre and other victims of sex trafficking.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff Giuffre respectfully requests judgment against Defendant Maxwell, awarding compensatory, consequential, exemplary, and punitive damages in an amount to be determined at trial, but in excess of the $75,000 jurisdictional requirement; costs of suit; attorneys' fees; and such other and further relief as the Court may deem just and proper.

JURY DEMAND

Plaintiff hereby demands a trial by jury on all causes of action asserted within this pleading.

Dated September 21, 2015.

/s/ David Boies
David Boies
Boies Schiller & Flexner LLP
333 Main Street
Armonk, NY 10504

/s/ Sigrid McCawley
Sigrid McCawley
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HOUSE_OVERSIGHT_015542

EXHIBIT H

IN THE CIRCUIT COURT OF THE
SEVENTEENTH JUDICIAL CIRCUIT, IN
AND FOR BROWARD COUNTY, FLORIDA

CASE NO.: CACE 15-000072

BRADLEY J. EDWARDS and PAUL G. CASSELL,

Plaintiff(s),

vs.

ALAN M. DERSHOWITZ,

Defendant(s).
_____/

NOTICE OF SERVING ANSWERS TO INTERROGATORIES

Plaintiffs, Bradley J. Edwards and Paul G. Cassell, by and through their undersigned counsel, hereby file this Notice of Serving Answers to Interrogatories with the Court propounded by the Defendant, ALAN M. DERSHOWITZ, on February 11, 2015, and that a copy has been furnished to the attorney for the Defendant.

I HEREBY CERTIFY that a true and correct copy of the foregoing was sent via E-Serve to all Counsel on the attached list, this 13th day of March, 2015.

JACK SCAROLA 750263
Florida Bar No.: 169440
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Fax: (561) 383-9451
Attorneys for Plaintiffs

13. Describe in detail Each instance in which Jane Doe #3 has provided information referencing Dershowitz by name that Concern the allegations set forth in Paragraphs 24-31 of the 2015 Jane Doe #3 Declaration.

ANSWER: Edwards and Cassell lack sufficient information to determine all circumstances in which Jane Doe No. 3 has mentioned to others Dershowitz's name as someone who abused her or had information relevant to abuse.

With regard to when she has provided information related to this subject to them, Jane Doe No. 3 provided such information in telephone calls with Brad Edwards beginning in 2011.

Jane Doe No. 3 has also provided this information in a public affidavit, filed on January 21, 2015, in the CVRA case. Jane Doe No. 3 has also provided similar information on other occasions, but the specifics of those communications are protected by the attorney-client privilege and the work product doctrine.

14. If You have ever seen a photograph or video of Jane Doe #3 with Dershowitz, then state when You saw the photograph or video, identify who took the original photograph or video, identify Each person who possesses a copy of the photograph or video, and state the location of Each such original and copy.

ANSWER: Edwards and Cassell have not personally seen such a photograph or video. Discovery efforts to obtain photographic materials regarding Jane Doe No. 3 held by the U.S. Attorney's Office for the Southern District of Florida and/or other federal law enforcement and prosecuting agencies are on-going.

15. For Each communication between You or anyone acting on Your behalf, and anyone from, or acting on behalf of, any media outlet Concerning this action, the Joinder Motion, or Dershowitz, and regardless of whether such communication was "on the record" or "off the record," (a) state the date of the communication; (b) state the participants in the communication; and (c) describe the contents of the communication.

ANSWER: Objection, not reasonably calculated to lead to the discovery of admissible evidence; vague, harassing, work-product.

16. Describe in detail All facts Concerning any assertion that Dershowitz was a "coconspirator" with Epstein.

ANSWER: See answers to interrogatory number 5 above, as well as answers to interrogatories numbers 1, 6, 8, 9, 10 above. In addition, factual information is found in the documents and other materials and references provided in answer to Request for Production Number 2

HOUSE_OVERSIGHT_015545

PAUL G. CASSELL

STATE OF UTAH)

COUNTY OF SALT LAKE)

The foregoing instrument was acknowledged before me this 11 day of March, 2015 by Paul Cassell who is personally known to me or who has produced personal knowledge (type of identification) as identification and who did/did not take an oath.

Susan Baca
Notary Public
~~State of Florida at Large~~ State of Utah SMB
My Commission expires:
Commission No:

Notary Public
SUSAN BACA
Commission #665643
My Commission Expires
April 19, 2017
State of Utah

Bradley J. Edwards

STATE OF FLORIDA)
)
COUNTY OF Broward)

BEFORE ME, the undersigned authority, personally appeared this day Bradley J. Edwards, who [✓] is personally known to me *or* [ ] produced _____, as identification, and who, after being duly sworn, did state that he/she executed the foregoing Answers to First Set of Interrogatories and that the same are true and correct to the best of his knowledge

Subscribed and sworn to before me this 12th day of March, 2015.

MARIA W. KELLJCHIAN
MY COMMISSION #EE840478
EXPIRES: OCT 03, 2016
Bonded through 1st State Insurance

Signature of Notary Public, State of Florida

Print / Typed Name, Notary Public

My commission expires:

HOUSE_OVERSIGHT_015547

EXHIBIT I

1 IN THE CIRCUIT COURT OF THE SEVENTEENTH
JUDICIAL CIRCUIT IN AND FOR
2 BROWARD COUNTY, FLORIDA

3 CASE NO. CACE 15-000072

4

5 BRADLEY J. EDWARDS and PAUL G. CASSELL,

6
Plaintiffs/Counterclaim Defendants,
7
vs.
8

9 ALAN M. DERSHOWITZ,

10
Defendant/Counterclaim Plaintiff.
11 _____/

12

13

14 VIDEOTAPED DEPOSITION OF

15 PAUL G. CASSELL

16 TAKEN ON BEHALF OF THE DEFENDANT

17 VOLUME I, PAGES 1 to 151

18

19

20 Friday, October 16, 2015

21 1:33 p.m. - 4:31 p.m.

22
110 Southeast 6th Street
23 110 Tower - Suite 1850
Fort Lauderdale, Florida 33301
24

25 Theresa Tomaselli, RMR

ESQUIRE SOLUTIONS

1 let me clear all of that misunderstanding up.
2 You know, that's -- frankly, if I had gotten
3 something like that, that's what I would have
4 said.
5 The answer that came back was -- from
6 Mr. Dershowitz was something along the lines of,
7 if I remember correctly, well, tell me what
8 you -- you -- tell me what you want to know and
9 I'll decide whether to cooperate, was I think
10 the phrase that was used. And -- and so there
11 was an attempt, you know, a 2009 attempt, a 2011
12 attempt to get information from Mr. Dershowitz.
13 Then there was another subpoena without
14 deposition for -- for documents. You know, we
15 have heard a lot about records in this case that
16 could prove innocence. There was a records
17 request to Mr. Dershowitz in 2013. And, again,
18 my understanding was that there was no -- you
19 know, no documents were provided on that.
20 And so those -- I had that information.
21 Another bit of information that I had was that in
22 2011, I believe in early April -- this is not
23 attorney/client privileged information from
24 Virginia Roberts. This is a telephone call that
25 she placed from Australia where she had been

EXHIBIT J

IN THE CIRCUIT COURT OF THE FIFTEENTH JUDICIAL CIRCUIT, IN AND FOR PALM BEACH COUNTY, FLORIDA

CASE NO.: 502009CA040800XXXXMBAG

JEFFREY EPSTEIN,

Plaintiff,

vs.

SCOTT ROTHSTEIN, individually,
BRADLEY J. EDWARDS, individually,
and L.M., individually,

Defendants.
_____/

NOTICE OF FILING

COMES NOW the Defendant/CounterClaimant, BRADLEY EDWARDS, by and through his undersigned counsel, and hereby files the attached transcript of the telephone interview of Virginia Roberts to supplement the proffer made in support of Counter-Claimant's Motion for Leave to Amend to Assert Punitive Damages.

I HEREBY CERTIFY that a true and correct copy of the foregoing has been furnished by U.S. Mail to all Counsel on the attached list on this 17 day of May 2011.

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HOUSE_OVERSIGHT_015554

PRIVILEGED PURSUANT TO FS 766.205(4) and/or WORK PRODUCT

TELECON

PARTICIPANTS: **JACK SCAROLA**
BRAD EDWARDS
VIRGINIA ROBERTS

RE: **Edwards adv. Epstein**
291874

DATE: **April 07, 2011**

JS: Virginia, Jack Scarola and Brad Edwards

BE: Hi Virginia.

V: Hi Jack! Hi Brad! How you guys doing?

JS: We're doing fine, thank you. I'm sorry for all of the trouble and before we go any further, let me tell you, if I have your permission, I have started a tape recorder and I want to be able to tape this conversation from the very beginning. Is that alright with you?

V: Sure, that's fine, Jack. No problem

JS: Ok, good, thank you. I appreciate that. Let me start off by introducing myself. I know that Brad has spoken to you about me but I am Brad's lawyer, and I assume that you can confirm that you and I have never had any communication before. Is that right?

V: That's correct.

JS: Alright. I have, however, gotten some information from Brad about conversations that you have had with him, and that will enable me, hopefully, to make this a little bit more efficient and take up a minimum amount of your time while still getting the information that we think is going to be helpful to us and to any jury that might ultimately have to hear these facts.

So, let me begin by asking you first to tell us what your full name is.

V: Virginia Louise Roberts. That's my maiden name. My married name is Virginia Louise [redacted].*

JS: Could you spell your last name for us? That is your married last name:

V: [redacted].*

JS: Alright, thank you, and where are you living right now?

V: I live in Australia.

JS: And how long have you resided in Australia.

V: This is my 19th year.

JS: That is where you are right now, correct? We've reached you in Australia for this phone conversation?

V: That is correct, yes.

JS: And what time is it in Australia right now?

V: I think it's about 9:00 now.

JS: Ok. That's 9am, correct?

V: That's correct.

JS: Alright. Virginia, the reason for this conversation is because it is our understanding that you know a man by the name Jeffrey Epstein, and I want to begin by asking you please to tell us about the circumstances of your first meeting Mr. Epstein.

V: Ok. I was introduced to Mr. Epstein by Ghislaine Maxwell. I was working at Donald Trump's spa in Mar-a-Lago and I was prompted by Ghislaine to come to Jeffrey's mansion in Palm Beach that afternoon after work to make some extra money and to learn about massage. She met me at the spa, and I was reading a book about anatomy, so I was already interested in massage therapy as it was and not having any of the education or you know anything behind me, I thought this was a great opportunity to work for her and go. So, I went to Jeffrey's mansion about 5 or 6 in the afternoon. My dad drove me there. My dad worked at Mar-a-Lago with me, and he met Ghislaine and she seemed like a nice, proper English lady, and she knows, I mean, you know, one time then _once before I left to travel overseas, she just seemed really nice and like she would like to help me out. So my dad left, and I had no problem getting home that night, one of her drivers would take me back after my trial. So she led me upstairs, and into Jeffrey's bedroom, and past that is Jeffrey's massage room, which has got his steam room and a shower and a massage table, and there is actually an extra room that has, that nobody knows about it, it's kinda like a secret room and it's got a whole bunch of decorative pictures of pornographic literature and sex toys and I can ___?___ what happened in there.

JS: When you say that the room was hidden, Virginia, how was the room concealed?

V: It wasn't like a door that you would normally go into, like some kind of special opening, you open that and then a little door, so it looks like it's a little closet so-to-speak, but when you walk in there, it's obviously a lot bigger than just a closet. It wasn't too big, but it was bigger, you know. It wasn't a gigantic room, it was just like a small room, which you know, it probably could fit some shoes in there, _it had racks of shoes, boxes, some sweatshirts neatly folded, and the ceiling to the floor was covered in pornographic pictures of the girls that he had met.

JS: When you say…

V: So anyways, that was getting there, and I was introduced to Jeffrey, he was laying naked on top of the massage table, and obviously for one, I'm a 15 year old girl and seeing him on the table was weird but, also learning about anatomy and massage, I thought this would be part of it. So obviously, I thought it was part of the massage program, so I said ok, this is fine. And, he then instructed me on how to touch the body, Jeffrey's body, how to massage him, and for the first hour, it was actually a real massage, maybe not an hour, maybe like 40 minutes or something, but of something like that _and that's when he turned over on the other side and to expose himself fully. So then Ghislaine told me that she wanted me to undress and began to take off my shirt and skirt, my white uniform from Mar-A-Lago, she also took off her shirt and got undressed, and so I was there with just my undies on, and she was completely bare, and made some kind of little flake about the underwear that I was wearing because it wasn't my normal sexy girl underwear and just like, I don't know, had red hearts on it or something like that; just your normal, you know, real cute underwear. Anyways, so during all of this I'm kind of like what's going on, how do I act, what do I say, I was so afraid of, not afraid or fearful for my life but _unsure of how all this started and wanting to obtain a profession_ I was so afraid thinking about upsetting and disappointing them, I don't know, it's a weird situation by far and I was expected to _Lick his nipples, instructed on how to do so by J.E_ and give him oral sex while he wanted to fondle me, and then at the end, I was told by Ghislaine to get on top and straddle Jeffrey sexually, and when we were done, we went and had a shower in the room and Jeffrey told me to wash him up and down, you know with a bar of soap and make sure he was all cleaned up. And then he took me downstairs and took me to two of the guards and told John to bring me home. John was the butler at the time.

JS: Let me interrupt you for just a moment there if I could, Virginia. You mentioned as you were recounting those details that you were 15 years old at the time. What is your date of birth?

V: August 9th, 1983

JS: And can you tell us please, as best you're able to estimate it, what the date was when this first encounter occurred?

V: I've got it written down. It's like - I'm not good with math – hold on – I thought I wrote it down but I didn't. I'm not too sure, I think it was 1998 off the top of my head and around June of 1998, I would say as I was turning 16 at the end of the summer.

JS: Alright. You talked about the room where Jeffrey had the pornographic photographs. Did you actually see that room on the occasion of your first visit there?

V: No, I got to see that room a few visits after but I was just trying to describe that room to you guys so you knew exactly what room I was talking about.

JS: Another question for you, and I don't mean to be prying into your personal life, and if I ask you any questions at all that you're uncomfortable answering, then you just tell me that and we'll move on, because I appreciate your cooperation and the last I thing I want to do is impose upon that cooperation, but can you tell us please just generally what kind of sexual experience you had had prior to this confrontation with Jeffrey?

V: Yeah, sure. A close family friend has sexually abused me, and I was on the streets at 13 years old. I was picked up by a 67 year old man named Ron _Eppinger_ who did exactly what Jeffrey did with me abuse and violate my youthfulness _ & I was with him for 6 months. So, he was gone and then I had this boyfriend who was like my school friend from young days but we just kept in contact with each other and we were on and off constantly, and that was Tony Figeroua_, and there was also another younger guy was near my age, Michael, I can't remember his last name, but yeah, there, I mean, there wasn't like a string of men or anything, but there was Ron, like I told you, and he was the first guy expecting me to do so-called disgusting affairs. Jeffrey actually knew Ron, which was quite weird when I told Jeffrey the story about Ron, and Jeffrey had actually met him, and yeah. Anyway, just another story, and yeah, there were a couple of men, but that gives you an idea.

JS: Now when you described the photographs in the room as pornographic, tell me just a little bit about the photographs, if you would please? First, how many of them were there?

V: At least 100, and like I said, they covered the room from the ceiling, not the ceiling but from the top of the edge of the wall to the bottom of the floor. I want to say at least a hundred, even more, there could have been more in the boxes _Some of them were A4_ photographs, like the large size, some of naked women posing, you know, positions, sexy positions. Others were, you know, some girls had bikinis on, and it wasn't so pornographic, but it was all women, and it was all in a sexual nature.

JS: Were there photographs where more than one person appeared?

V: Oh yeah, plenty of them. There were lots of naked photographs, I mean I was just trying to give you a visual range. There was anything from 5x6s to 4x8s to 8x4s. Some of them

had frames, some of them were out of frames, but they were all, like I said, they were all women, they were all sexual in nature.

JS: Was it your impression that there were a hundred photos of a hundred different people or were there multiple photos of the same woman or girl?

V: There was definitely a lot of different girls. I mean it wasn't easy to sit there and say, you weren't finding 5 girls out of some photos, no. Were there a hundred different ones? There could have been pictures of some girls, I really couldn't get close necessarily to actually recognize faces or anything like that. But if you, you know, the range of them were all different, majority of them were different, yeah.

JS: Did there ever come a point in time when you became aware that a photograph of you had been added to the collection?

V: Yes, there was. Ghislaine took several nude photographs of me for Jeffrey. So, yeah, there were pictures of me and there were pictures, he wasn't shy, that wasn't the only place in his house that he kept the photos. He liked photos all over his house. If you looked in his den or on his desk or in on the hall table, a giant hall table in his house, there were at least a hundred photos of girls in frames. Not all of them were naked, a lot of the ones that were all around his house were not naked girls posing pornographically, some were pictures of celebrities and politicians he had known_or things like that or had pants on or whatever, but yeah, there was a lot of mixed photographs in the outside ones.

JS: Were there any photographs of girls or young women that you knew or that you subsequently came to know that you saw in the house?

V: Yeah, yeah, there was. There was pictures of Nadia Bjournik_____, pictures Sarah Keller, pictures Emmy, pictures of me, pictures of the regulars, but a lot of the girls, sometimes Jeffrey could have like 7 girls a day, and he would only see those girls once if he got bored. I don't know. These weren't my days. I heard he's gotten a lot sloppier since I left. So, I don't know anyways, but when I knew him, there was just a, it seemed, there was such an influx of girls coming in and out, so did I recognize a lot of them? Maybe, maybe not, but then they were all definitely beautiful, they were all ranging in age, some of them young, some of them older in their 20's, I mean it was just they were all beautiful.

JS: You've told us about the first visit. Was there any discussion on the occasion of that first visit about your returning?

V: Yes, they were very pleased with me and after the encounter was finished, the sexual encounter, he went and told me I did well and I have a lot of potential to become a massage therapist and if I'd like I could return tomorrow, you know, and do the same thing and get paid $200/hr, so Jeffrey insisted that I come after work, and over the next few days, I guess the relationship grew into more, and within a couple of weeks, not even

a couple of weeks, maybe a week, I had quit Mar-a-Lago and I was working for Jeffrey full time.

JS: Ok, let's talk about your job at Mar-a-Lago, if we could. You said that your Dad was working there. What was his position at Mar-a-Lago?

V: He was a maintenance supervisor I think is what it was called? He like managed the tennis courts and air conditioners and things like that.

JS: What is your Dad's full name?

V: Sky William Roberts.

JS: And is he still living here in South Florida now?

V: No, he's not, he's in California.

JS: Ok. Is your Dad aware of what is currently going on with regard to your having made public statements about your relationship with Jeffrey?

V: Yes, he is well aware of it. I told my family even before all this stuff came out, because they were the first ones contacted by the journalists from Mail on Sunday. I know that they the Mail on Sunday printed that I had gone out and tried to, I mean I think one of the photos said that I was angry that I saw Jeffrey and the Prince walking together and that is why I came out and went public with everything. Not true. I mean, I am angry about how they are still up to their old ways together and that they're still hanging out but I didn't contact the Mail on Sunday and I didn't bring it out. I figured that everyone was going to bring it out anyway and I better bring it out the right way. He's known everything from the start, and my family is very supportive with everything going on.

JS: I'm kind of going to jump around a little bit and I apologize for that, but since the subject has come up, tell me first of all why you are providing this cooperation to us, and I am certainly very appreciative of it, but I want you to tell us why it is you've chosen to spend time with us on the telephone and provide this information that you're now providing.

V: I'm out to help the bigger picture, you know, I think all of us can make a big difference in a lot of other people's lives and I think that this has gone on long enough and it's a big slap in my face that he can get away with hurting me so bad let alone so many other girls and laugh about it. I guess I talked to you guys out because I want to see the right thing happen, not just to him, but I want people in the world to understand this is not the way of life, you know, it's not acceptable to go out procure young girls and make them think that, this is the way you should be living and that's all. Yeah, I guess my reason for doing it is to help the bigger picture, you know, I'm a big believer in karma and I believe that good things will come back to you, so I guess that's why I'm doing this.

JS: Just for the record, neither Brad, nor I, nor anyone representing that they have anything to do with us has made any promises to you. Is that correct?

V: That is correct. I'll tell you, since this is our first conversation, that nobody has made me feel like I've been bribed or bought or had to say anything. I've told you anything that I know from my own self, not some things somebody told me. If anything, Brad's been extra careful not to tell me anything and let me do all the talking, so it's quite opposite I think.

JS: Alright. Let's get back then to the story of your relationship with Jeffrey, and we've talked about your first encounter with him and how it evolved from that into your full time employment with Jeffrey, but what were you doing at Mar-a-Lago before you quit Mar-a-Lago?

V: I was just a locker room attendant and sometimes I did babysitting for the rich and famous. So, I wasn't anything big. I worked in the spa area. That's why I was studying anatomy, because I was really really interested in becoming a _massage therapist_, and at the locker room, I didn't do much. I mean I was making tea for a living, I would, you know, make sure the toilet paper had a little triangle in it after everybody went to the toilet, or wipe down the water from the basin, you know, it was a very easy peasy job.

JS: Did you get that job through your Dad?

V: Yes, my Dad got me the job.

JS: Ok, and you were only 15 years old at the time, were they aware of how old you were at Mar-a-Lago?

V: Of course, definitely. We had to go through extensive, you know, we even had to get drug tested and id test and so on and so forth. I mean, Mantas (?) is very strict on employment, yeah, everybody knew.

JS: Ok. Was there ever any conversation with Ghislaine about how old you were before you were taken to Jeffrey's mansion?

V: No. She didn't ask me how old I was from the start, but when I did get to Jeffrey's mansion, it was discussed how old I was.

JS: With whom?

V: During the entire hour of what I call the legitimate massage I was giving him, it was cat and mouse games getting information from me to find out who I am, am I a willing participant in these kind of things, and how would I react if they were about to take the next step. But they got information off of me, they got my age, they got my, a little bit of my history so they knew I was, you know, not very stable at home, and they knew that,

you know, I was actually interested in making my life better by studying so what they were offering me was a chance to become a legitimate masseuse but it was getting trained. They would have people show me how to work the body and be called a massage therapist and get me books on it, and you know, keep me interested, and every time, you know, I was with Jeffrey, literally was about massages, I don't mean just going in and have sex with him. I mean massage, because it would always start out with massage and then it would lead into sometimes other things.

JS: Alright, once this evolved into full time employment, what did full time employment mean?

V: That was entirely having to travel with Jeffrey in every city. When he was in Palm Beach, I stayed at my apartment, and he would call me to his house once or twice a day sometimes, and that's, you know, do things with him. Sometimes we'd go out shopping, sometimes we'd go out and watch a movie. You know, simple things like that, go to an expo or a fair, whatever it was. But when we were in other cities, I was at my apartment_, I lived with him full time. What I mean by full time is even in the middle of the night, I could get a ring on my phone next to me and tell me to come in his room, you know, so it was literally full time.

JS: When you say that when you were in Palm Beach you were living in your apartment, were you living on your own or were you living with members of your family at that time?

V: No, after I quit Mar-a-Lago, Jeffrey offered to get me an apartment in Palm Beach somewhere, Royal Palm Beach, and it was a nice apartment. He furnished it for me, it was absolutely beautiful, but yeah, that's the only time I would spend time away from him really.

JS: This apartment was on Royal Palm Beach Boulevard or out in the Village of Royal Palm Beach?

V: I so honestly don't remember. I've been trying to rack my brain because the FBI was asking the same thing and were trying to find it, but yeah, I'm Not sur_. I didn't get to spend as much time in it, I was only there about an entire week out of every month probably, but the majority of the time I was with Jeffrey anyways. It was somewhere in Royal Palm Beach. I don't know about Royal Palm Beach drive. I don't even remember the Royal Palm Beach drive anymore so I'm not too sure.

JS: Ok, let me see if I can draw the distinction for you and maybe that will help you to help us? Royal Palm Beach is a village that is…

V: No, no, no, I got Royal Palm Beach, I just didn't know the Royal Palm Beach Drive, like what street it's off of. Were you talking about a street?

JS: Yes, I was talking about a street. Royal Palm Drive is on the island of Palm Beach, and it's a street that is lined with large royal palm trees, and I'm wondering if this was an apartment on the island or was this an apartment out west of town…

V: No, it was actually in Royal Palm Beach, not on the island.

JS: Alright.

V: I would be driven, it was closer to my family than it was closer to him. I wanted to be close enough to everybody else so that when I was in town, I could just go see them quickly.

JS: Ok. So we're not talking about Royal Palm Boulevard. We're talking about the town of Royal Palm west of town. Jeffrey got you an apartment out there.

V: That's correct.

JS: When he was in Palm Beach, you were generally not staying at the mansion, you were staying at the apartment that he got for you out west of town.

V: That's correct.

JS: Ok.

V: I mean then there was times, I don't wanna say that every time I stayed at my apartment. There was times we'd fly back from some city maybe too late at night to really want to go back home, so you know, it's like 12:00 at night or 1:00 in the morning. I was just staying in the yellow room, or something like that; one of the guest rooms in Palm Beach. But majority of the time, I would definitely want to get back to my own apartment.

JS: Alright. What were the general hours of your full time employment when …?

V: There was not set hours. It wasn't like logging, and you know, hitting the shift button, nothing like that. The way I would get paid would be, ok, if I was in Palm Beach, I would get $200 an hour to massage Jeffrey or some of his friends and then go home. So it would be like that. If I was traveling with him, it would be per massage, so I would be getting paid per day. So I wouldn't be getting paid on an hourly rate. He wouldn't say ok, today you're going to work for me from 7:00 in the morning until 8:00 at night. It never like that. I was on call all the time.

JS: When you were here in Palm Beach, were you actually getting paid only for the time spent massaging Jeffrey or were you getting paid from your arrival at his house until you left the house?

V: From the time the massage started.

JS: From the time the massage started. Ok.

V: Sometimes we'd go there and I would wait for a while or talk with Ghislaine and Jeffrey about something or we'd meet somewhere and talk about something. A lot of times, I'd meet him upstairs in his room where he was ready for me. But then there was a lot of times where it didn't start right away, so he couldn't really pay me from the time I got there sometimes unless it was just paid from the time I massaged him til the time the massage was over.

JS: Alright. Did your duties for Jeffrey ever include anything other than providing him massages and sex in connection with the massages? Did he ever give you any other responsibilities to perform?

V: I was asked to do the same things that I did to Jeffrey to a few of his fellow colleagues as well. Those were my duties. He looked at it this way is that I was going to be a professional massage therapist, and maybe I needed some clientele, so he had me perform erotic massages on a few people.

JS: Did that start here in Palm Beach County?

V: It did. The first one did.

JS: Ok, and how long after you first met Jeffrey did he first ask you to provide services for one of his friends?

V: About 9 months, I think it was. It wasn't a full year, it wasn't 6 months, but between 6 months and a year, which is why I'm saying 9 months.

JS: And when you provided services to a friend of Jeffrey's, who paid you for those services?

V: Jeffrey would. I would get paid the next time I saw Jeffrey, so if I was invited to the Breakers Hotel to give a massage, I would give a massage, I would go home, and the next day when I saw Jeffrey, he would pay me for what I did. So, it was paid always by him, it was set up by him, so he always knew what to pay me. I did get tips and things like that, if you call it that, you know, like a hundred dollar tip or something from a few of them, you know, yeah.

JS: Was there ..

V: There was always payment from Jeffrey.

JS: Was there ever any discussion with Jeffrey about what was expected to happen when you provided massage services to one of Jeffrey's friends?

V: In a roundabout way, yes. In so many ways, Jeffrey really really had to train me, and that was why Ghislaine said that she and Jeffrey enjoyed me so much was because they never really had to speak much to me to tell me what they wanted me to do. You know, I wasn't waiting for you know, their directions. Jeffrey would tell me to go give an erotic massage to friends. He wouldn't give me much detail about it, but he would say to treat them like you treat me.

JS: Did he refer to it as an erotic massage or are those your words?

V: Erotic massage is my words. That's exactly what it was, but he would tell me to treat them how he wanted it, so I'd do what he wanted without having to say to me words more. I mean, I complied with what he wanted because it was somewhat of a, I don't know, I don't know how to say it, it was just very mindboggling how I let him have so much control or power over me basically. The massages would be routine to what Jeffrey wanted with my so called new clientele, and with their own words would ask me to provide them with sexual pleasure after the massage.

JS: Did you ever report back to Jeffrey about what happened when you provided massages to his friends?

V: Of course, of course, and I knew that his friends were reporting back to him as well because there were times where he would instigate conversation by saying you know, so and so had a great time, you did wonderful, you know so and so gave me a call and told J.E how it went_...

JS: Did Jeffrey ever elicit details from you? "Tell me what happened, describe in detail what went on?"

V: No, but he would have a laugh, he had a laugh with me a few times about some of their different mannerisms, I guess you would say, like some of them, one guy had a foot fetish and that was really weird and I mentioned it to Jeffrey, and we would have a laugh over it. He didn't want to know details. He wasn't asking me "so tell me what did you guys do exactly." No, he just basically gave me a slap on the back and said, you know, good job. And we had some kind of conversation about it. I can't recall any conversation off the top of my head. I really don't know one. It's been that long. But yeah, we did talk about it briefly.

JS: Can you give me an estimate as to the number of friends for whom Jeffrey provided and paid for your services?

V: There was about, you know, I don't know, 8 guys possibly.

JS: And are you able to name those people for me?

V: No, not at this stage. I just, some of these people are really influential in power, and I don't want to start another shitstorm with a few of them. I'll tell you that there was some erotic massages given to, I'm just afraid to say it to you.

JS: Ok, Virginia.

V: It's like geez, I don't know if I want to, I'm really scared of where this is gonna go.

JS: Alright. I understand that, and as I told you from the beginning, if I ask you a question that you are uncomfortable answering, you just tell me that, and I will move on, and I understand that at least right now, you are uncomfortable answering, and I am certainly going to respect that.

V: Thank you so much, Jack.

JS: No, that's quite alright. I am very appreciate of the cooperation you are providing, and I don't want you at any time to feel that we are taking unfair advantage of that cooperation, so give me the information that you're comfortable giving me, and if we get to a point where you're uncomfortable, I will respect that and we'll move on from there.

V: Ok.

JS: I want to talk a little bit about the traveling that you did with Jeffrey. About how long into your relationship with him did that first start?

V: Immediately. I started traveling immediately. Not internationally until I think about, Gosh, I can't remember even, I think it was a year later that we started doing international travel. Maybe like 9 months to a year again. Not too sure to be honest.

JS: So that would have been approximately the summer of 1999? Somewhere around there?

V: Yes. Somewhere around there. Somewhere around a year, somewhere around there, I can't pinpoint it exactly. But like I said, we started doing domestic traveling immediately, so my first destination with him was New York and Santa Fe and the Carribean, California, I would take trips with him occasionally. Sometimes we would go to St. Louis or New Orleans or Santa Cruz. We were traveling just about everywhere I think.

JS: How did you travel?

V: Well, we took Jeffrey's private jet, and unless I was being sent somewhere by myself for what we were just talking about before, then I would travel on a what do you call, a public jet, whatever it is…

JS: commercial flight?

V: Yes. Just a normal flight, an e-ticket.

JS: Like the rest of us common folk.

V: But when I was traveling with Jeffrey, the majority of the time would be on the black jet.

JS: Now, when you say there would be times when you would travel by yourself because he was sending you somewhere, tell me about that. How did that come about?

V: So, one of his colleagues would be at the Carribean or Santa Fe or even New York, or wherever, and he would call me up on those days where I am not working with him or in Palm Beach with him, and he would ask me to get on the next plane to so and so and go meet so and so, and that's when I would take e-tickets. His secretary or special assistant, whatever, would organize it for me and give me the details and I would just walk up the line and they'd let me right through.

JS: Can you give me any ideas as to how many times it happened that Jeffrey would send you off to meet some friend of his at some location outside of Palm Beach?

V: How many times it happened? I'm not too sure. Probably about 10-15 times.

JS: Ok. And on those occasions, how much time would you spend with one of Jeffrey's friends when you were sent to a location that you would have to travel to?

V: Only a couple of days. Only 2 days, that's it.

JS: And how were you paid for those trips?

V: I would be paid in cash upon my arrival back with Jeffrey. So, whenever I was back with Jeffrey, he would count up how many days I've had, sometimes give me even more than what I deserved, not deserved, but what I earned and give me a little extra.

JS: Was there a daily rate for those trips or was that per massage also?

V: Per massage. With Jeffrey, I would be honest. I wouldn't tell him I did 15 massages if I didn't. He knew he could trust me. He could always come back to the other person that he sent me to give massages and ask them as well, so you know, it was always by per massage.

JS: Alright. When we've been talking about massages, tell me exactly what it is we're talking about when we speak about massages.

V: Same thing I would do to Jeffrey. Again, it would start out as a massage, which would start with them being naked, and me giving him a legitimate massage to begin with, so

I'd start with his feet, go up to his calves, up his legs, buttocks, back, his neck, his head, his arms, yada yada, and then it would be time to flip over, and some of the men would want me to continue on massaging the front side of them and they would instigate me to begin having sex with them or foreplay, whatever you want to call it.

JS: So routinely, these massages involved sexual activity. Is that accurate?

V: That is accurate.

JS: Ok. Let's talk about the travel that you were involved in when you were on Jeffrey's private plane. Generally speaking, who were the passengers on the plane when you traveled.

V: Well, Larry was the pilot, and then there was a short, small solid guy, I don't know his name, but he was a co-pilot, and then he changed and there was another guy brought in later on. Generally speaking, there was always Jeffrey, sometimes Ghislaine, sometimes Emmy, sometimes a whole bunch of other girls, sometimes famous people, sometimes some politicians or yeah, just about anybody could fly on his plane. There was never no any set routine who would come and who would go. It was an influx of people on Jeffrey's airplane.

JS: I want to deal with these things separately in order to respect some of the reservations that you have, so I'm going to ask you who the people were that you remember flying with Jeffrey on his plane when you were personally present without regard to whether there was any sexual activity that occurred on the plane or not. So I'm not asking you to implicate any of these famous people in improper conduct, but just tell me what the names of the people are that you remember that you consider to be famous people.

V: Ok, there was Naomi Campbell, Heidi Klum, there was Bill Clinton. There was Al (?) Gore, there was a whole bunch of models, I wouldn't really honestly be able to give their names. There was Matt Groning the producer of the simpons cartoon, Jack CCousteau's granddaughter a lot of interior designers, architects, politicians. I am just trying to think of as many names as possible for you. Off the top of my head, that's as good as I can get for now.

JS: Ok, alright, that's fine. And again, I am not implying by my questions, nor do I want your answers to be interpreted as your suggesting that any of those people that you have just identified were engaged in any improper activities on any particular flight, but I want to talk to you now about what went on on occasion on the airplane. Ok?

V: Ok. It was a lot of the same thing that went down on the ground. A lot of times, it would be just be me and Jeffrey, or me and Jeffrey and Ghislaine, or me and Jeffrey and some other girl, sometimes Emmy, Sarah, and Nadia Bjournik. There would be sexual conduct, there would be foreplay, there was a bed in there, so we could basically reenact exactly

what was happening in the house. It would start off with massaging or we would start off with foreplay, sometimes it would lead to, you know, orgies.

JS: Were there occasions when you were in Jeffrey's company, whether on the ground or in the air, where there were other girls present whom you knew to be under age 18?

V: Yes. There was a constant influx of girls coming in and going out. And we were all very young. On occasion, there was some older girls, and I don't mean older as in like in their 30s or anything, I mean like 28, 29, something like that, just very rarely. The majority of the girls that Jeffrey actually met or had on his plane or in his house were under age.

JS: Do you know how it is that Jeffrey established with any of these underage girls?

V: Yes, I do. He would send me personally or with other girls to clubs or shops, to _pick up anywhere, I mean we were constantly on the look for other girls that might satisfy Jeffrey.

JS: What instructions were you given about what to look for?

V: Young, pretty, you know, a fun personality. They couldn't be black. If they were any other descent other than white, they had to be exotically beautiful. That was just about it.

JS: Who gave you those criteria?

V: They both gave us the instructions, and it wasn't just me, Jeffrey asked most girls to bring a friend and make extra money. They would use us young girls So that way it probably looked a lot more safer to a girl that we were procuring to younger girls that were already doing it. That was the way that Jeffrey had it.

JS: Were you given any instruction at all on how to approach these girls?

V: Yes. Jeffrey and Ghislaine both taught me to, depending on the circumstances, depending on the girl, you could offer them a job as a massage therapist or you could tell them you have a really rich friend with, you know, great contacts in the acting world or modeling world and he loves pretty girls, you should come back and meet him, make some money, you know, we had a whole bunch of ways to be able to procure girls.

JS: Can you give me any idea as to the total number of underage girls that you know engaged in sexual conduct with Jeffrey during the period of time you had your relationship with him?

V: I would have no way of estimating that whatsoever. I mean, there could be a hundred, there could be more, honestly I'm not too sure how many girls, really. I wish I did know. I mean like I said there were so many over the course of 4 years with Jeffrey.

JS: Let me see if we can try to narrow it down a little bit. Is there any doubt in your mind that it was more than 10?

V: Yes, there was definitely more than 10.

JS: Ok, what I want you to do is to give me the highest number that you are comfortable in saying there were definitely more than X number of underage girls that I know Jeffrey Epstein engaged in sex with while I had a relationship with him. How would you fill in that blank? Definitely more than how many?

V: I'd say definitely more than a hundred.

JS: Alright. Did Jeffrey ever help to pick out your clothes?

V: Oh yes. I mean he wasn't out to dress me like a porn star or anything. He would always dress me very classy, but we'd just go shopping all the time together.

JS: Did he ever express any style preferences in terms of how he wanted you to dress? Besides dressing classy, I'm, you know, any other suggestion to you about how he wanted you dressed?

V: He didn't, like I said, wasn't trying to dress me in any prostitute way or anything like that. It was nice, classy outfits I was wearing like Gucci, Dolce Gabbana, Chanel, things like that. He was buying me a lot of very, very nice clothing. It was provocative. I mean I was wearing miniskirts, and tight short shorts and little shirts that showed my belly and my cleavage and everything, but they were very expensive clothes.

JS: Was there every any dress up role playing?

V: Yes. There was. Lots of it. Jeffrey loved the latex outfits Ghislane had for us girls, he had bondage outfits, he had all different kinds of outfits, but his favorite was the schoolgirl.

JS: Tell me about that.

V: Well, you know, Ghislaine would take me to dress me up to surprise J.E or Jeffrey would ask me to get dressed up, that would include wearing a tiny little skirt with nothing underneath, a white collared shirt that you would be wearing to school with a tie in it, tied up _in a bow_, my hair in pigtails, stockings on up to my knees, and I would go in there and act like a kid and we'd do role playing sexing.

JS: Did Jeffrey ever brag to you about the age of any of the girls with whom he had relationships?

V: Yes, he did. He did all the time. The worst one that I heard from his own mouth was this pretty 12 year old girls he had flown in for his birthday. It was a surprise birthday gift from one of his friends and they were from France. I did see them, I did meet them. Jeffrey bragged afterwards after he met them that they were 12 year olds and flown over from France because they're really poor over there, and their parents needed the money or whatever the case is and they were absolutely free to stay and flew out. Those were the worst ones. He was constantly bragging about girls' ages or where he got them from or their past and how terrible their past was and good he is making it for them.

JS: Where were the 12 year old girls flown to from France? Where did they come to?

V: Palm Beach.

JS: And were they flown in on Jeff's private plane or did they get transported?

V: No. They were transported by somebody else.

JS: Ok. Was the sexual activity that went on on the airplane conducted in such a way so that any of the crew was aware of what was going on?

V: They were told to knock if they had to come out, if the crew had to come out. They were told, you know, to come out as little as possible, so they weren't out there hanging out watching everything, no, but it doesn't take an idiot to put two and two together to say well there's a whole bunch of half dressed teenagers on board with this old man who is constantly being massaged by them and he wants me to keep the door shut for what reason? I mean, only they could put that together, but yeah, they knew.

JS: Did Mr. Epstein ever talk to you about people of power and influence owing him favors?

V: He would laugh about it, you know, I never really knew what to take serious from Jeffrey because he was such a funny character at times. You never knew if what he was saying was true or not. Yeah, lots of people owed him favors from what he told me. He's got everybody in his pocket, and he would laugh about he helps people for the sole purpose in the end they owe him something. That's why I believe he does so many favors in the first place.

JS: When and how did you first become aware that Mr. Epstein was in trouble with the law?

V: I was first informed by, I think someone from the FBI called me first and started to ask me questions, and I started to answer the questions but then fear took over, and I just said look, I don't know what's going on, I've got a young family that I don't want to risk, you know, please don't bother me about this again, and it was real short simple conversation, and within a week or 2, I had gotten a call from Jeffrey's attorney, and then a week later, Jeffrey himself.

JS: Ok, well let's back up before we get to those conversations and tell me approximately when it was that you were contacted by the person who you believe was with the FBI.

V: Ok. It's hard for me to pinpoint, if I had to pinpoint it, it would be in 2007 sometime.

JS: Alright. And you were living in Australia at that time, correct?

V: Correct.

JS: You were contacted by telephone?

V: That's correct, by my cell phone.

JS: Ok and do you have any idea how your name came up leading to that contact.

V: No idea. No idea whatsoever. When I did ask, I was told that some girls had revealed my name, I guess, and that's how everybody, the FBI knew to contact me.

JS: OK.

V: But I don't know offhand or sorry, I just walked into the wrong room.

JS: Ok.

V: Sorry go on.

JS: Yes & I'll never tell her you said that. Virginia, how long was it after that phone call from the FBI person were you contacted by Mr. Epstein's lawyers.

V: Like a week. It was back to back to each other. I remember being so scared after talking to the FBI thinking what's happening, what's going on. It's been like 6 years, 7 years at that stage, how did they find me & what do I have to do with this? So yeah, I do remember that very well, and it was only about a week later I was called by his attorney.

JS: Who was it that contacted you, do you remember?

V: I want to say Bill Riley, but he might have been from the FBI. No, it was Bill Riley. Bill Riley. Not sure if that's his correct name, but that's what is coming to mind

JS: What do you remember about that conversation?

V: I remember a Mr. Goldberger as well, I remember, there might have been two of them.

JS: Alright.

V: I can't remember which one it was. I want to say Bill Riley is the good one.

JS: Alright, so either Bill Riley or a Mr. Goldberger or both of them contacted you, and what do you remember about that?

V: I don't know if it was the same guy who contacted me that week later who put me in touch with Jeffrey. I think he was on the phone and he put speakerphone on with Jeffrey. So he connected me with Jeffrey. I don't know if it was the same guy or different, but I definitely know that Bill Riley was the first guy to contact me. I'm pretty sure about that.

JS: Ok. Tell me about that conversation.

V: He asked me what I knew about what's going on with Jeffrey and apparently, there was an investigation being held about some of the girls who had come out and said that Jeffrey had sexual contact with them under the age of a minor and that he was discrediting lot of these girls and making them out to be drug addicts and prostitutes and what have you so they wouldn't be looked upon as worthy in the court's eyes so to speak. And you know, he told me in the first five minutes that, you know, if I stay quiet, that "I'll be looked after" . And that was the exact way it was said. It wasn't like you know, I'm gonna pay you a zillion dollars or anything if you be quiet, but if I stay quiet, I would "looked after". And I remember saying I don't want any part to do with this. You know, this is not something I want to be a part of, I've got a young family. I wish the best for everybody in this, you know, take care kind of thing. A week later, I was called after the hearing by one of Jeffrey's lawyers. I can't tell you exactly which one it was but he had Jeffrey on the other line and he connected Jeffrey and I, and Jeffrey tried to make some simple conversation, "How are you? How have things been?" You know what I mean, catching up.

JS: Do you know if the lawyer, did the lawyer stay on the line while Jeffrey was speaking to you?

V: I'm pretty sure he did. That's why I think Jeffrey was on speaker phone because it sounded a lot different, and I was never taken off the line to begin with or connected to another line, so I was pretty sure Jeffrey was on speaker phone and the lawyer was making the call. After the simple conversation, it led to what was going on again and you know, Jeffrey couldn't believe it. You know, he thought he helped all these girls out. He didn't think he was wrong in any circumstance here at all. A lot of these girls were drug addicts and just after drug money. You know, he was really putting down these women or these girls I should say, not giving them the credit they deserved, and then he exactly repeated what the lawyer said the week before is that he would look after me if I stayed quiet, and if I need any help, you know, his lawyers would represent me and he would get legal help for me, whatever I need, he would do, and I told him exactly, I said, "Jeffrey, I'm the mother of two children at that stage. I'm away from everything there, I don't want to be a part of it. I'm not going to speak to anybody and I don't want to speak to anybody, I don't want to be involved." That was the last time I heard from him. And the

next thing I knew, I was sent my victim's letter, my notification of being a victim through the US Attorney's Office and that's when I knew it was well out there enough not to have Jeffrey's lawyers come back on me and discredit me in the same way he had done to all the other girls. So, I called up Joseph Bird who was the recommended lawyers on my paperwork that they had given me and started going from there.

JS: So you contact Mr. Joseph Bergs' office and then you were dealing with his office from that point forward.

V: That's correct.

JS: Tell me about the ending of your relationship with Jeffrey. That is, at what point in time did your full time employment end and how did that happen?

V: Ok. So, it hadn't really ended. I walked away from it all. Jeffrey sent me to Thailand where I met my husband and escaped to Australia, never to return back to the states. About 6 months prior to that, he came up with a proposition that I thought was really disgustingly sick. And it really showed me for the first time in 4 years I had been with him that nothing was going to change and I was always just going to be used by him(?) which I did not like. He offered me a mansion and some of his money every month, I forget what he called it, a monthly income of what he made to bear one of his children. The proposition was that if anything ever happened between Jeffrey and I, that I would have to sign my child over to him basically and that the child would be his and Ghislaine's, and I would be looking after it as long as nothing happened between Jeffrey and I. So, I was kind of freaked out by all of that. I pushed Jeffrey more to please get me some more training, you know, and I was getting older and not of as much interest to Jeffrey anyways. I was 19 now, and he likes a female a lot younger. So he sent me to Thailand, in September 2002_. I was first supposed to meet a girl there and bring her back with me, but I never met up with her. I proceeded get a short course in Thai massage so that was to shut me up about my training so I went there, and one of my friends from school invited me to watch a fight, like a muay thai fight, which is like a form kickboxing. So I went and watched it, and I saw this guy that was a really good fighter, and a girl's word, looked really hot, so I asked my friend who knew him to introduce me. We got introduced and fell in love immediately, 3 days later Rob proposed and 7 days later I was being married in a buddist temple. I called Jeffrey and told him I'm sorry, I'm never coming back. I've gotten married, I've fallen in love. I thought he'd wish the best for me but he was kind of rude and he just said "have a good life" and hung up the phone, and that was the last time I'd talked to him ever until all this started again.

JS: Ok. Virginia, is there anything else that you would like to add to what you have told us up to this point in time?

V: I'd like to know that this time around something's going to be done about it and that Jeffrey and a lot of his colleagues, no matter how rich they are, will know that there is

law and that there is people that still believe in it. So that's it. Thank you guys for listening to me, hearing me out and helping me. It's kind of hard to get through.

JS: Thank you very much. Yes, I'm sure it has been very difficult and I am very appreciative of the courage you have shown in doing what you have done, which really brings me to the last subject, and that is what was it that motivated you to go public with all of this?

V: Sharon Richard contacted me. I like her, I do, I like her a lot. I know she's a journalist, and journalists are normally bloodsucking leeches, but I like her for that, but she is an honest bloodsucking leech. She told me a lot about what was still going on, and she showed me a picture of Jeffrey with a little girl who looks like she could have been 12 years old. I mean it was disgusting. I agreed to talk with her, I never agreed to do anything until she showed me some pictures, and at that stage, being a mother of 3 children and having a daughter who I would do anything for to protect, I would put my neck on the line to make sure she never has to go through what I had to go through, and knowing all of this, and knowing that he's still out there doing the same exact thing with no regrets, no remorse, no worry about what he's doing to those girls, and all those girls feeling the same way that I did, so I, you know, I'm doing it because I believe in my heart of hearts it's the right thing to do. It's what I would want somebody to do for my daughter or my sister or my friend, and it saddens me to know that it's still going on right now. It's like the seashell story. I don't know if you're heard the story about the little kid who throws back a starfish, you know, the little brother tries to ask his sister, "why do you throw them in, they're all gonna die anyways, the little girl says "well, it's this one that I can help, and this one that I can help," and that's what I feel like I'm doing. I'm making a small dent in this big world we live in.

JS: I certainly appreciate that courage, and I have heard that story, and you're absolutely right, that one person may not be able to make a difference for everyone, but one person can make a difference for someone, and hopefully, you are making a difference for someone, and we're gonna do the best we can to make sure you are making a difference for as many people as possible.

V: Thanks Jack.

JS: Just a few other follow up things I want to ask you and again, if any of these questions are questions that you're uncomfortable in responding to, then don't hesitate to tell me that. Do you have any recollection of Jeffrey Epstein's specifically telling you that "Bill Clinton owes me favors"?

V: Yes. I do. It was a laugh though. He would laugh it off. You know, I remember asking Jeffrey what's Bill Clinton doing here kind of thing, and he laughed it off and said well he owes me a favor. He never told me what favors they were. I never knew. I didn't know if he was serious. It was just a joke.

JS: Where was here?

V: He told me a long time ago that everyone owes him favors. They're all in each other's pockets.

JS: When you say you asked him why is Bill Clinton here, where was here?

V: On the island.

JS: When you were present with Jeffrey Epstein and Bill Clinton on the island, who else was there?

V: Ghislaine, Emmy, and there was 2 young girls that I could identify. I never really knew them well anyways. It was just 2 girls from New York.

JS: And were all of you staying at Jeffrey's house on the island including Bill Clinton?

V: That's correct. He had about 4 or 5 different villas on his island separate from the main house, and we all stayed in the villas.

JS: Were sexual orgies a regular occurrence on the island at Jeffrey's house?

V: Yes.

JS: If we were to take sworn testimony from the people I am going to name, and if those people were to tell the truth about what they knew, do you believe that any of the following people would have relevant information about Jeffrey's taking advantage of underage girls? So I'll just name a name, and you tell me yes if they told the truth, I think they'd have relevant information or no, I don't think they would, or I don't know whether they would or not. Ok? You understand?

V: Yes.

JS: Ok. Les Wexner.

V: I think he has relevant information, but I don't think he'll tell you the truth.

JS: Ok. Alan Dershowitz.

V: Yes.

JS: David Copperfield.

V: Don't know.

JS: Tommy Matola.

V: Don't know.

JS: Prince Andrew.

V: Yes, he would know a lot of the truth. Again, I don't know how much he would be able to help you with, but seeing he's in a lot of trouble himself these days, I think he might, so I think he may be valuable. I'm not too sure of him.

JS: Ok. Virginia, I think that's all I have for you. Let me tell you what I would like to do. As I told you in the beginning of this conversation, we've been recording it, and hopefully, we've got a clear enough recording so that we've taken down everything accurately and when it's transcribed, it will be clear and accurate, but what I would like to do is transcribe it, send it to you, have you take a look at it, and if there's anything that we got wrong in the statement, you can write back and you can make changes in the transcript so that the transcript is accurate. Is that fair?

V: No worries. That is fair. No problem.

JS: Alright, great. I really do appreciate that and tell me what the best way is to send the transcript to you.

V: Email. If you just want to send it by email or if you want to send it by mail, either or.

JS: Ok. Give me your email address if you would please.

V: [redacted]*

JS: Let me read that back to you: [redacted]*

V: Yep that's it.

BE: Thank you Jenna, appreciate it.

V: No problem, Brad.

JS: Thank you very very much. Bye Bye now.

V: Take care Jack. Nice meeting you.

JS: You too.

*Redaction has been made at the request of the witness.

EXHIBIT K

From: Donna Paine <djpaine@aol.com>
Sent: Friday, January 23, 2015 2:31 PM
To: Paul Cassell
Cc: brad@pathtojustice.com; JWI@SearcyLaw.com; matt.williams@itn.co.uk; kate.brannelly@itn.co.uk
Subject: Re: Jeffrey Epstein case

Thank you, Paul. I had reached out to Joan previously to be included on Jack Scarola's e-mail distribution list for the Dershowitz suit, but I wasn't sure if this would also be handled by them.

I don't want to double up or inundate you, as I know other ITN News colleagues have also been in touch with you. I just wanted to make sure I was on your radar if Judge Marra rules next week.

Best,
Donna Paine

Sent from my iPad

On Jan 23, 2015, at 1:10 PM, Paul Cassell <cassellp@law.utah.edu> wrote:

Hi Donna,

I am passing this information along to Joan, who will add this information into our contacts list. Thanks for your interest in this important case.

Paul

Paul G. Cassell
Ronald N. Boyce Presidential Professor of Criminal Law
S.J. Quinney College of Law at the University of Utah
332 South 1400 East, Room 101 Salt Lake City, UT 84112-0730
Voice: 801-585-5202 Fax: 801-581-6897 Email: cassellp@law.utah.edu
You can access my publications on http://ssrn.com/author=30160
CONFIDENTIAL: This electronic message - along with any/all attachments - is confidential. This message is intended only for the use of the addressee. If you are not the intended recipient, you may not use, disseminate, distribute or copy this communication. If you have received this message in error, please immediately notify the sender by reply electronic mail and delete the original message. Professor Cassell is admitted to the Utah State Bar, but not the bars of other states. Thank you.

From: djpaine@aol.com [mailto:djpaine@aol.com]
Sent: Friday, January 23, 2015 9:47 AM
To: brad@pathtojustice.com; Paul Cassell
Cc: matt.williams@itn.co.uk; kate.brannelly@itn.co.uk
Subject: Jeffrey Epstein case

Hi Brad and Paul --

I had reached out to you both the other week when the allegations of Jane Doe #3 first became public. I am a freelance TV producer in South Florida, working with ITN News on this story. As you can imagine, given her allegations against Prince Andrew, ITN is quite keen on covering this story as soon as it breaks.

EXHIBIT L

From: Paul Cassell
Sent: Saturday, January 24, 2015 1:25 PM
To: Michael Bilton
Subject: RE: from Michael Bilton - latest from Daily Mail online

Hi Michael,

We got the information. Thanks very much.

This is a very interesting article that puts a lot of the flight log information together.

http://gawker.com/flight-logs-put-clinton-dershowitz-on-pedophile-billio-1681039971

Let's stay in touch. Hopefully more and more of the truth will out. PC

Paul G. Cassell
Ronald N. Boyce Presidential Professor of Criminal Law
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You can access my publications on http://ssrn.com/author=30160

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From: Michael Bilton [michaelbilton1@btinternet.com]
Sent: Friday, January 23, 2015 6:04 PM
To: Paul Cassell
Subject: Re: from Michael Bilton - latest from Daily Mail online

You should have had from me a couple of zip files concerning VR's travel seen alongside Prince Andrew's engagements. Has that arrived with you?

M
On 24 Jan 2015, at 00:58, Paul Cassell wrote:

> Thanks for the note – looks like various pieces are falling together. PC
>
> Paul G. Cassell
> Ronald N. Boyce Presidential Professor of Criminal Law
> S.J. Quinney College of Law at the University of Utah

EXHIBIT M

Mary E. Pirrotta

From: Mary E. Pirrotta
Sent: January 22, 2015 9:38 AM
To: 'Lindsay.Isaac@turner.com'
Cc: Joan Williams
Subject: Re: Edwards, Bradley vs. Dershowitz Document: Complaint (File #: 20150013)
Attachments: Complaint.pdf; The Duke of York.pdf

Attached is a copy of the Complaint in Case No. CACE 15-000072 and also a copy of Mr. Scarola's letter to The Duke of York per your request.

Is the full transcript of our telephone interview with Virginia part of the public record?
I have a request from the press to provide it (see below), but I will only do that if it has been filed. TAKE THIS OUT

Begin forwarded message:

From: "Hill, James E." <James.E.Hill@abc.com>
Date: January 28, 2015 at 10:34:00 AM EST
To: Jack Scarola <JSX@SearcyLaw.com>
Subject: RE: Question from ABC

If possible - I'd also like to see full transcript of the 2011 phone interview you/Edwards conducted with VR while she was still in Australia.

-----Original Message-----
From: Hill, James E.
Sent: Wednesday, January 28, 2015 9:31 AM
To: 'Jack Scarola'
Subject: RE: Question from ABC

Thank you

-----Original Message-----
From: Jack Scarola [mailto:JSX@SearcyLaw.com]
Sent: Wednesday, January 28, 2015 7:19 AM
To: Hill, James E.
Subject: Re: Question from ABC

You will receive a response and copy of the deposition later this morning.

On Jan 27, 2015, at 10:00 PM, "Hill, James E." <James.E.Hill@abc.com> wrote:

Hi Jack - sorry to trouble you.

But wondering if you know what documents are source for a new NY Daily News story - quoting what appears to be a Juan Alessi deposition which mentions Andrew visits to PB mansion.

Daily News cites newly filed documents. I'm not aware of any new docs that quote Alessi on the issue of Andrew.

Can u enlighten me?

Do you have access to those portions of the Alessi depo? Not sure which case it would come from.

http://m.nydailynews.com/news/national/prince-andrew-sex-massages-epstein-home-repairman-article-1.2094073

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Chicago
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****
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****
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****

EXHIBIT N

Paul Cassell

From: Paul Cassell
Sent: Saturday, January 3, 2015 11:14 AM
To: Paul Blake
Subject: RE: questions for Dershowitz

Questions for Alan Dershowitz

1. Have you ever met a young girl, under the age of 18, in the presence of Jeffrey Epstein or on one of Jeffrey Epstein's properties?

2. How many times have you visited Jeffrey Epstein's mansion in West Palm Beach, Florida?

3. The U.S. Attorney's Office for the Southern District of Florida reached a non-prosecution agreement with Jeffrey Epstein, in which he agreed to make civil restitution for sexual abuse committed against 40 girls at the mansion. Do you have any reason to doubt that that Jeffrey Epstein sexually abused 40 underaged girls.

4. Didn't Jeffrey Epstein tell you that he repeatedly had sex with these underage girls?

4. Jeffrey Epstein is a now a registered sex offender. Do you have any reason to doubt that this registration is appropriate?

5. Have you ever met Ghislaine Maxwell in the presence of Jeffrey Epstein or at one of his properties?

6. Did you send correspondence to the U.S. Department of Justice in Washington, D.C. (or elsewhere) attacking the credibility of these 40 girls?

7. According to testimony in court cases, when Jeffrey Epstein was at his mansion in West Palm Beach, Florida, he would receive almost daily "massages" that were in fact sexual encounters with these underage girls. Do you have any reason to doubt this testimony?

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8. The U.S. Attorney's Office gave Epstein a non-prosecution agreement that extended immunity from federal prosecution not only to Epstein but also "any potential co-conspirator". Isn't it normal practice for federal prosecutors only to extend immunity to specifically named persons, not an open-ended group of "any" co-conspirator.

9. How did you travel to Epstein's mansion in West Palm Beach?

10. How many times have you been to Epstein's private ranch, called "Zorro", in New Mexico?

11. How many times have you been to Epstein's private island in the U.S. Virgin Islands, known as Little St. John's.

12. Did you ever see young girls present at Little St. John's?

13. If we talk about the time frame of 1998 to 2001, how many times a year were you making telephone calls to Epstein?

14. How many times have you flown on Epstein's private plane?

15. Did you ever see young girls, potentially under the age of 18, on Epstein's private plane?

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Filing # 37357304 E-Filed 02/03/2016 12:44:44 PM

IN THE CIRCUIT COURT OF THE
SEVENTEENTH JUDICIAL CIRCUIT
IN AND FOR BROWARD COUNTY, FLORIDA

CASE NO.: CACE 15-000072

BRADLEY J. EDWARDS and
PAUL G. CASSELL,

Plaintiffs/Counterclaim Defendants,

vs.

ALAN M. DERSHOWITZ,

Defendant/Counterclaim Plaintiff.

_____/

DEFENDANT/COUNTERCLAIM PLAINTIFF ALAN M. DERSHOWITZ'S *REDACTED* MOTION TO MODIFY CONFIDENTIALITY ORDER

Defendant/Counterclaim Plaintiff, Alan M. Dershowitz ("Dershowitz"), by and through undersigned counsel, hereby files his *Redacted* Motion to Modify Confidentiality Order of January 12, 2016, and in support thereof states the following:

On January 16, 2016, Defendant Alan M. Dershowitz began the deposition of non-party Virginia Roberts Giuffre ("Roberts"). Pursuant to this Court's January 12, 2016 Confidentiality Order, that transcript currently is under seal. The Confidentiality Order should be modified at least to allow Dershowitz to defend this case. Dershowitz and his counsel need to be able to contact witnesses, inform them of Roberts's testimony, and ask them whether Ms. Roberts's testimony is accurate. They also need to be able to use Ms. Roberts's testimony in other ways as part of the defense effort, such as by providing it to expert witnesses, among other things. The bottom line is that Dershowitz's counsel must be able to use Roberts's testimony as necessary in their professional judgment to represent their client, as a matter of fairness and due process.

Accordingly, Dershowitz requests that the Court modify the Confidentiality Order to confirm that Dershowitz's counsel may disclose Ms. Roberts's testimony as they deem necessary in their professional judgment in order to represent Dershowitz in this case.

BACKGROUND & EXECUTIVE SUMMARY

Dershowitz was first presented with Roberts's heinous and false allegations against him when her lawyers, Bradley J. Edwards ("Edwards") and Paul G. Cassell ("Cassell"), filed certain now-stricken allegations in the action styled *Jane Doe, et al. v. United States of America*, No. 08-80736 (S.D. Fla.) (the "Federal Action"). After Dershowitz defended himself to the media, Edwards and Cassell sued Dershowitz for defamation. The falsity of Roberts's allegations, her credibility, and the investigation her lawyers took to assess those allegations and credibility before filing those allegations are a critical part of Dershowitz's defense.

On April 9, 2015, Roberts moved for an order "quashing the subpoena *duces tecum* served on her by Defendant, or alternatively, pursuant to Florida Rules of Civil Procedure 1.280(c) for issuance of a protective order sharply limiting the scope of the subpoena" (the "Motion to Quash"). *See* Motion to Quash, attached hereto as Exhibit A. Roberts did not move to seal the deposition transcript and the resulting order did not seal it, but instead directed that "a confidentiality order shall be entered." *See* November 4, 2015 Email from Judicial Assistant Susan Moss, attached hereto as Exhibit B and November 12, 2015 Order, attached hereto as Exhibit C. The Confidentiality Order then prepared by Roberts's counsel and consented to by all parties includes a provision stating that "[t]he deposition testimony of Non-Party Virginia Giuffre will be designated as 'Confidential' and not subject to public disclosure" and that "[i]t may only be filed under seal." *See* January 12, 2016 Confidentiality Order, attached hereto as Exhibit D.

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Dershowitz now requests that the Court modify the Confidentiality Order to allow Dershowitz to use the transcript for those limited purposes as deemed necessary in the professional judgment of his counsel to ensure Dershowitz is afforded his right to build and present his defense.

I. DERSHOWITZ MUST BE ALLOWED TO CONTACT WITNESSES AND ADVISE THEM OF WHAT ROBERTS ALLEGES IN ORDER TO VERIFY OR DISPROVE HER ALLEGATIONS AND CREDIBILITY AND DETERMINE WHETHER PLAINTIFFS EVER MADE EFFORT TO CONTACT THESE INDIVIDUALS TO VERIFY ROBERTS'S ALLEGATIONS AND CREDIBILITY.

As explained by Plaintiffs Edwards and Cassell in their Response to Dershowitz's Motion to Determine Confidentiality, the "sexual abuse allegations filed by Edwards and Cassell for their client Ms. Virginia Giuffre are not peripheral to this lawsuit – *they are inherent to it*." Plaintiffs' Response to Dershowitz's Motion to Determine Confidentiality, November 23, 2015, attached hereto as Exhibit E at 4 (emphasis added). Those "sexual abuse allegations filed by Edwards and Cassell for their client" go beyond Dershowitz. Another *inherent* part of this lawsuit is what investigation, if any, Plaintiffs undertook with respect to the scope of Roberts's allegations, all of which bear upon her credibility. Dershowitz argues that Plaintiffs did not perform a reasonable investigation before making the allegations in the Federal Action. Plaintiffs argue that they did. Dershowitz must be allowed to contact witnesses and advise them of what Roberts alleges so that Dershowitz can not only verify or disprove her allegations and credibility, but also determine whether Plaintiffs ever made efforts to contact key witnesses to verify Roberts's allegations and credibility. As explained by one Florida court, "[o]penness in courts has a salutary effect on the propensity of witnesses to tell the truth" as it "informs persons affected by litigation of its effect upon them . . . ." *John Doe-1 Through John Doe-4 v. Museum of Sci. & History of Jacksonville, Inc.*, No. 92-32567-CI-CI, 1994 WL 741009, at *1 (Fla. Cir. Ct. June 8, 1994) (internal citations omitted).

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As set forth in Dershowitz's Motion for Clarification of Confidentiality Order or Relief from that Order, filed Jan. 29, 2016, it appears that Roberts made false statements in a publicly filed affidavit about being present at a private island in the US Virgin Islands when former President Clinton was there. Indeed, former FBI Director Louis Freeh determined based on the response of the federal government to a FOIA request that the absence of records responsive to the request "strongly establishes that former President Clinton was not present on Little St. James Island during the period at issue." *Id.* at 2. If Roberts made a false statement under oath about former President Clinton, it is equally if not more likely that she has made false statements about others whose whereabouts are more difficult to track.

Roberts cannot reasonably argue her testimony is confidential as [redacted] *See* Excerpts of Roberts's Deposition Transcript, attached hereto (under seal) as Exhibit F.[1] [redacted] *See id.*; *see also* March 2, 2011, Sharon Churcher, Daily Mail, attached hereto as Exhibit G. Dershowitz has also discovered that Roberts [redacted] *See* Exhibit F; *see also* AD-006931-006933, Transcript of Telephone Conversation Between Alan M. Dershowitz and Rebecca, attached hereto as Exhibit H. As a result, Roberts cannot claim that these allegations are confidential simply because [redacted]

[1] As per the Confidentiality Order, Exhibit F is only filed under seal.

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II. DERSHOWITZ MUST BE ALLOWED TO SHARE ROBERTS'S DEPOSITION TRANSCRIPT WITH THOSE WORKING ON DERSHOWITZ'S BEHALF AS PART OF THIS LITIGATION.

Dershowitz asks the Court to modify the Confidentiality Order to allow Dershowitz to use the transcript in ways necessary for his defense including sharing the transcript with any counsel and other legal support, experts, consultants, insurers, and others typically permitted access to supposedly confidential information in addition to using it with potential witnesses and others as deemed necessary in the professional judgment of his counsel as set forth above. Dershowitz and his attorneys are aware of and will abide by the Florida Rules of Professional Conduct, including its comments, regarding the handling of any information deemed by this Court to be confidential within the limitations of the applicable rules.

III. ALLOWING DERSHOWITZ TO USE THE DEPOSITION FOR THE LIMITED PURPOSES OF HIS DEFENSE IS REQUIRED BY FLORIDA LAW.

Florida law requires that any sealing order be the least restrictive means necessary to accomplish its purpose. The Florida Supreme Court held in *Barron v. Florida Freedom Newspapers*, 531 So. 2d 113 (Fla. 1988), that a sealing order can be entered only where "no reasonable alternative is available to accomplish the desired result, and, if none exists, **the trial court must use the least restrictive closure necessary to accomplish its purpose.**" *Id.* at 118 (emphasis added); *see also Carter v. Conde Nast Publ'ns*, 983 So. 2d 23, 26 (Fla. 5th DCA 2008) ("an order sealing court records must state, inter alia, the particular grounds for making the court records confidential, that the closure is no broader than necessary, and that there are no less restrictive measures available.").

This Court has not set forth any reasons addressing a request by Roberts to seal her deposition transcript, much less determined that "no reasonable alternative is available" to accomplish Roberts's desired result. *See News-Press Publ'g Co. v. State*, 345 So. 2d 865, 867

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(Fla. 2d DCA 1977) ("The judge's statement that he had 'cogent reasons' for sealing the records obviously fell short of specifically setting forth the reasons why public access to these deposition was being denied."). Moreover, Roberts and Plaintiffs cannot argue that sealing her deposition in its entirety is "the least restrictive" option, as it is most certainly the *most* restrictive option and one that Florida courts take very seriously. "[A] closure order must be drawn with particularity and narrowly applied." *Barron*, 531 So. 2d at 117.

Here, that requisite "least restrictive" application requires, at a minimum, allowing Dershowitz to use Roberts's testimony for the limited purposes necessary in the professional judgment of his counsel to represent their client, as a matter of fairness and due process.

CONCLUSION

Because Dershowitz must be able to prepare his defense and any sealing order must be the least restrictive measure available, the Court should modify the Confidentiality Order to confirm that Dershowitz's counsel may disclose Roberts's testimony as they deem necessary in their professional judgment in order to represent Dershowitz in this case.

HOUSE_OVERSIGHT_015595

Respectfully submitted,

Dated: February 3, 2016

s/Thomas E. Scott
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Counsel for Alan M. Dershowitz

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CERTIFICATE OF SERVICE

I HEREBY CERTIFY that a copy of the foregoing has been electronically filed through the Clerk of Broward County by using the Florida Courts eFiling Portal and thus served by electronic mail: jsx@searcylaw.com, mep@searcylaw.com, scarolateam@searcylaw.com to: **Jack Scarola, Esq,** Searcy Denney Scarola Barnhart & Shipley, P.A., Counsel for Plaintiff, 2139 Palm Beach Lakes Blvd., West Palm Beach, Florida 33409; jonijones@utah.gov to: **Joni J. Jones, Esq.**, Assistant Utah Attorney General, Counsel for Plaintiff Cassell, 160 East 300 South, Salt Lake City, Utah 84114; brad@pathtojustice.com to: **Bradley J. Edwards, Esq,** Farmer, Jaffe et al, 425 North Andrews Avenue, Suite 2, Ft. Lauderdale, FL 33301; cassellp@law.utah.edu, to: **Paul G. Cassell, Esq.,**; smccawley@bsfllp.com, sperkins@bsfllp.com, to: **Sigrid S. McCawley, Esq.**, Boies Schiller & Flexner, LLP, 401 E. Las Olas Blvd, Suite 1200, Ft. Lauderdale, FL 33301, this 3rd day of February, 2016.

By: *s/Thomas E. Scott*
Thomas E. Scott
FBN: 149100
Steven R. Safra
FBN: 057028

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EXHIBIT A

Filing # 25919336 E-Filed 04/09/2015 05:23:25 PM

IN THE CIRCUIT COURT OF THE 17TH
JUDICIAL CIRCUIT IN AND FOR
BROWARD COUNTY, FLORIDA

CIVIL DIVISION

BRADLEY J. EDWARDS, and
PAUL G. CASSELL,

Plaintiffs,

v.

ALAN DERSHOWITZ,

Defendant.
_____/

CASE NO. CACE 15-000072

MOTION TO QUASH OR FOR PROTECTIVE ORDER REGARDING SUBPOENA SERVED ON NON-PARTY JANE DOE NO. 3

Non-party Jane Doe 3, by and through undersigned counsel and pursuant to Florida Rules of Civil Procedure 1.410(c)(1)[1], hereby moves for an order quashing the subpoena *duces tecum* served on her by Defendant, or alternatively, pursuant to Florida Rules of Civil Procedure 1.280(c) for issuance of a protective order sharply limiting the scope of the subpoena.

INTRODUCTION

This Court should quash the subpoena issued to non-party Jane Doe No. 3 as it is unreasonable and oppressive. The Defendant is abusing the subpoena power in an effort to intimidate, harass and cause undue burden to a non-party. Indeed, Defendant - just days ago - publicly admitted that his goal of deposing Jane Doe No. 3 has nothing to do with this Florida Defamation Action; rather, he is trying to find a way to send this victim of sexual trafficking to "jail." "She was hiding in Colorado…but we found her and *she will have to be deposed. The end*

[1] For the limited purpose of the Motion to Quash or for Protective Order and resolving the scope of the subpoena and any enforcement issues, Jane Doe No. 3 voluntarily submits herself to this Court's jurisdiction.

result is that she'll go to jail because she will repeat her lies and we'll be able to prove it and she will end up in prison for perjury." (emphasis added). *See* Exhibit 1, New York Daily News, April 7, 2015. Defendant has subjected Jane Doe No. 3 to horrific public attacks including publicly calling her a "prostitute" and a "bad mother" to her three minor children. *See* Exhibit 2, Local 10 News, January 22, 2015.

Defendant has gone on a media blitz campaign against this non-party for statements she made under oath in a federal action: "The end result of this case should be *she [Jane Doe No. 3] should go to jail*, the lawyers should be disbarred and everybody should understand that I am completely and totally innocent." (emphasis added). *See* Exhibit 3, CNN International, New Day, January 6, 2015. "*My goal is to bring charges against the client and require her to speak in court.*" (emphasis added). *See* Exhibit 4, Australian Broadcasting System (ABC), January 6, 2015. Defendant also stated, in an interview in Newsmax, that he is "considering" bringing a lawsuit against Jane Doe No. 3. "*And we're considering suing her for defamation* as well, but right now she was trying to hide in Colorado and avoid service, but we found her and we served her and *now she'll be subjected to a deposition*." (emphasis added). *See* Exhibit 5, Newsmax, April 8, 2015.

Defendant's own words demonstrate that he is abusing the subpoena power of this Court to try to get discovery that is irrelevant to this case, in the hopes of being able to intimidate Jane Doe No. 3 with the press and generate a claim against her. Considering the extensive abuse that Jane Doe No. 3 suffered as a minor child, and Defendant's threats and intimidation, it would be both unreasonable and oppressive to require this non-party to comply with this subpoena *duces tecum*. Accordingly, Defendant's subpoena should be quashed. *See* Exhibit 6, Defendant's Subpoena to Jane Doe No. 3.

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BACKGROUND

The underlying action before this Court is a defamation case filed by a former federal judge, Paul Cassell, and his colleague Brad Edwards, who represent various sexual trafficking victims in a case pending in the Southern District of Florida, specifically case no. 08-cv-80736-KAM, hereinafter ("CVRA case"). As a result of an affidavit filed in the CVRA case, Defendant went on a national media defamation campaign calling, among other things, former federal judge Paul Cassell and attorney Brad Edwards, "unethical lawyers" who should be "disbarred". *See* Exhibit 7, Today Show, January 5, 2015. In response to this national slander campaign by the Defendant, Paul Cassell and Brad Edwards filed a defamation case against Defendant in the Circuit Court of the Seventeenth Judicial Circuit for Broward County, Case No. CACE 15-000072, hereinafter "Florida Defamation Action").

Defendant's statements against Paul Cassell and Brad Edwards are statements about their character as lawyers and do not directly involve non-party Jane Doe No. 3. Despite this fact, Defendant is abusing the subpoena power in this case by seeking documents from a non-party that are irrelevant to the defamation issue before this Court. Defendant is determined to find a way to harm non-party Jane Doe No. 3 and anyone who braves to represent her. Jane Doe No. 3 has good cause to be fearful of the Defendant in this matter based on Defendant's repetitive threats. *See* Exhibit 8, Affidavit of Jane Doe No. 3. This Court should not allow Defendant to abuse the subpoena power to further abuse this non-party. Florida Rules of Civil Procedure provide a vehicle for this Court to protect a non-party from a harassing, burdensome and unnecessary subpoena. As explained below, non-party Jane Doe No. 3 should be protected from having to be deposed in this matter or produce documents. Defendant's campaign of threats and intimidation should not be condoned by this Court and Defendant's subpoena should be quashed in its entirety.

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ARGUMENT

1. This Court Should Quash Defendant's Abusive Subpoena In Its Entirety.

Florida Rule of Civil Procedure 1.410(c)(1) provides that the Court may "quash or modify the subpoena if it is unreasonable and oppressive." *Id.* The Court has discretion to evaluate the circumstances in determining whether the subpoena is "unreasonable and oppressive." *Matthews v. Kant*, 427 So. 2d 369, 370 (Fla. 2d DCA 1983). "The sufficiency thereof is a factual determination for the trial judge who is vested with broad judicial discretion in the matter, and whose order will not be overturned absent a clear showing of abuse of discretion." *Id.*; *see also Sunrise Shopping Center, Inc. v. Allied Stores Corp.*, 270 So. 2d 32 (Fla. 4th DCA 1972) (Fourth DCA quashing lengthy subpoena served on non-party who was not in control of documents as being "oppressive and unreasonable."). It is undisputed that Jane Doe No. 3 was sexually trafficked as a minor child by Jeffrey Epstein and he was sentenced for his crimes. Allowing the Defendant in this case to force this non-party to provide discovery on this highly sensitive topic would be both oppressive and unreasonable and serves no purpose other than to foster Defendant's publicly admitted and utterly baseless campaign to try to send Jane Doe No. 3 to "jail."

The documents requested in Defendant's subpoena demonstrate the oppressive and unreasonable nature of the requests. Defendant, for example, seeks highly personal and sensitive information from this victim of sexual trafficking, including requesting her personal diary during the time when she was being sexually abused as a minor child. *See* Exhibit 6, Request no. 16. Defendant also demands that this non-party produce photographs and videos of her as a minor child while she was being sexually trafficked by convicted sex offender Jeffrey Epstein. *See* Exhibit 6, Request nos. 2, 3, 4 and 10. Defendant's unreasonable subpoena even includes a demand for this non-party's personal cell phone records for more than a three (3) year period during the time when she was a minor child being sexually trafficked. *See* Exhibit 6, Request no.

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15. Defendant also demands items like personal financial documents from this non-party including payments she received from convicted sex offender Jeffrey Epstein and the men he "lent" this minor child out to from 1999 – 2002. *See* Exhibit 6, Request no. 20. It is without question that Defendant is abusing the subpoena power in this case to conduct a fishing expedition in an effort to intimidate and harass this victim and to try to dig up information he can use in his openly stated "goal" to send this non-party to "jail."

Jane Doe No. 3 is rightfully fearful of Defendant as he is an incredibly powerful individual and the legal counselor to convicted Jeffrey Epstein who sexually trafficked Jane Doe No. 3 for years when she was a minor child. *See* Exhibit 8, Affidavit of Jane Doe No. 3. Jane Doe No. 3 believes Defendant's goal is to abuse the subpoena power to get her into a deposition so he can harass and intimidate her by forcing her to discuss the abuse she had to withstand as a minor child. *See* Exhibit 8, Affidavit of Jane Doe No. 3. None of that childhood abuse is relevant to this case which involves the narrow issue of whether Defendant defamed two lawyers. Defendant's subpoena is both unreasonable and oppressive and should be quashed. *See Matthews v. Kant*, 427 So. 2d 369, 370 (Fla. 2d DCA 1983).

2. <u>The Court Should Quash The Subpoena In Its Entirety, But At A Minimum, It Should Severely Limit The Production Requirements.</u>

In addition to its power to quash the subpoena, Florida Rule of Civil Procedure 1.280(c) also allows the Court to protect a non-party from discovery that would result in "annoyance, embarrassment, oppression or undue burden or expense…" *Allstate Ins. Co. v. Langston*, 655 So. 2d 91, 94 (Fla. 2003) (Florida Supreme Court overturning denial of protective order and holding that "[d]iscovery of certain kinds of information 'may reasonably cause material injury of an irreparable nature.'") (internal quotations omitted). *Matthews v. City of Maitland*, 923 So. 2d 591, 595 (Fla. 5th DCA 2006) (quashing discovery order where "[t]he compelled disclosure… would create a chilling effect on [petitioners] rights…"). The Court may determine that "the discovery

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not be had" or that "the discovery may be had only on specified terms and conditions…". Fla. R. Civ. P. 1.280(c).

Defendant issued a vastly overbroad subpoena to this non-party which included 25 separate document requests, many with subparts. In addition to placing an undue burden on this non-party to have to search for the broad scope of materials requested, the document requests seek information that is irrelevant to the Florida Defamation Action and clearly intended to "embarrass and oppress" this non-party. Fla. R. Civ. P. 1.280(c). Defendant's overly broad subpoena to non-party, Jane Doe No. 3, goes so far as to seek documents relating to former President, Bill Clinton and former Vice President, Al Gore, which, even if such documents existed, would be absolutely irrelevant to the Florida Defamation Action. *See Toledo v. Publix Super Markets, Inc.*, 30 So. 3d 712 (Fla. 4th DCA 2010).

Defendant's requests can be grouped into four key categories: (1) documents that contain highly personal and sensitive information sought only to harass, embarrass and intimidate the non-party; (2) documents unrelated to this action and, instead, intended to gain discovery relating to Defendant's admitted "goal" of putting this non-party in "jail," bringing a new case against Jane Doe No. 3, or related to the federal action; (3) documents that contain personal financial or other confidential information; and (4) privileged communications between the non-party and her lawyers. Non-party, Jane Doe No. 3, has filed specific objections as to each request sought in Defendant's subpoena as set forth in Exhibit 9. Here, Jane Doe No. 3 provides the Court with a sampling of the oppressive nature of the subpoena that is the subject of her detailed objections.

a. Category 1 – Overly Broad Subpoena Requests Intended Solely to Harass, Embarrass and Intimidate the Non-Party by Seeking Highly Personal and Sensitive Information

It is clear from the Defendant's requests that his intent is to intimidate and harass this non-party by seeking highly sensitive personal information that is irrelevant to this action. For example, Request no. 16 seeks "Any diary, journal or calendar concerning your activities between

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January 1, 1999 and December 31, 2002." Defendant is seeking personal diary information during the time this non-party was a minor child and a victim of sexual trafficking. There is no reason this non-party should be forced to produce her diary from when she was a child. *See Peisach v. Antuna*, 539 So. 2d 544 (Fla. 3rd DCA 1989) (court of appeal holding that trial court departed from the essential requirements of law by granting deposition of party's gynecologist which was only meant to invade privacy and intimidate and harass the party).

Defendant also has a number of requests (Request nos. 2, 3, 4, 10 and 19) that seek "photographs" and "videos" of this non-party when she was a minor child and during the time she was the subject of sexual abuse. Photographs of Jane Doe 3 when she was a minor child are completely irrelevant to the matter before this Court. Defendant served this subpoena demand solely to intimidate, harass and embarrass this non-party and the Court should preclude this type of discovery set forth in Request Nos. 2, 3, 4, 10, 15, 16, 19 and 21. *See Citimortgage, Inc. v. Davis*, No. 50 2009 CA 030523, 2011 WL 3360318 (Fla. 15th Cir. Ct. April 4, 2011) (trial court granting protective order precluding a deposition noting "this deposition request is mere harassment" and had no relevance to the underlying dispute where the party was wrongfully using the discovery process for personal gain).

b. Category 2 – Clear Abuse of the Subpoena Power By Seeking Documents Unrelated to this Action and Intended Instead to Provide Discovery for Other Actions

Defendant is abusing the subpoena power of this Court by issuing subpoena requests that are intended to obtain discovery for the development of other actions against this non-party and are unrelated to the instant case. *See* Exhibit 5, Newsmax Interview ("And we're considering suing her for defamation as well, but right now she was trying to hide in Colorado and avoid service, but we found her and we served her and now she'll be subjected to a deposition."). Defendant has admitted that his "goal" is to put Jane Doe No. 3 in "jail" and he is using this Court's subpoena power to go on a fishing expedition in the hopes of fulfilling his ultimate stated

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"goal." *See Toledo v. Publix Super Markets, Inc.*, 30 So. 3d 712 (Fla. 4th DCA 2010) (court of appeal quashing discovery order where party sought law firm client file relating to a different matter holding that "curiosity" about a law firm's records does not satisfy the relevance requirement and explaining that the contents of the "subpoena is a classic 'fishing expedition' and the trial court's order departs from the essential requirements of the law."); *Calvo v. Calvo*, 489 So. 2d 833, 834 (Fla. 3d DCA 1986) (quashing subpoena served on wife's bank for financial records finding them irrelevant: "*indeed, the husband has failed to demonstrate what possible relevance the records might have in the proceeding below other than to harass the wife*."). (emphasis added).

Defendant's incredibly broad and unrelated demands include, for example, Request no. 24: "All documents concerning, relating or referring to your assertions that you met former President Bill Clinton, Former Vice President Al Gore and/or Mary Elizabeth "Tipper" Gore on Little Saint James Island in the U.S. Virgin Islands." *See* Exhibit 6, Request no. 24. Whether or not Jane Doe No. 3 met any of these individuals has absolutely nothing to do with the action before this Court. *See Allstate Ins. Co. v. Langston,* 655 So. 2d 91, 94 (Fla. 2003) (Florida Supreme Court holding that "we do not believe a litigant is entitled carte blanch to irrelevant discovery" and '"It is axiomatic that information sought in discovery must relate to the issues involved in the litigation, as framed in the pleadings.'") (internal citations omitted). Defendant's Request demonstrates a blatant example of abuse of the subpoena power.

Indeed, the face of many of Defendant's subpoena demands demonstrate that he is using the subpoena power of this Court to obtain discovery for the federal action. Request nos. 1, 5, 6 and 9 all reference the "federal action" or specifically cite the declaration and case number "OS-SO736-CIV-MARRA/JOHNSON. Request no. 1, for example, demands: "All documents that reference by name, Alan M. Dershowitz, which support and/or confirm the allegations set forth in Paragraphs 24-31 of your Declaration dated January 19, 2015 and/or Paragraph 49 of your

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Declaration dated February 5, 2015, which were filed with the United States District Court for the Southern District of Florida, in Jane Doe #1 and Jane Doe #2 v. United States of America, Case No. OS-S0736-CIV-MARRA/JOHNSON, [ECF No. 291-1] (the "Federal Action")." Defendant should not be using the subpoena power of this Court to issue a non-party subpoena for documents sought for a federal action.[2]

c. Category 3 – Documents that Contain Personal Financial Information Completely Irrelevant to this Action

Defendant also wrongfully abuses the subpoena power to seek personal financial information from this non-party. *See Woodward v. Berkery*, 714 So. 2d 1027, 1034-38 (Fla. 4th DCA 1998) (quashing lower court's discovery order and finding irreparable harm to husband in disclosure of private financial information when wife's *clear purpose was to wrongfully disclose the financial information to the press*) (emphasis added); *see also Granville v. Granville*, 445 So. 2d 362 (Fla. 1st DCA 1984) (court of appeal overturning denial of protective order and finding that private financial information should have been protected from disclosure).

The requests are clearly meant to intimidate and harass her by, for example, seeking information during the time she was the subject of sexual trafficking by Jeffrey Epstein. Request no. 20 seeks "All documents showing any payments or remuneration of any kind made by Jeffery Epstein or any of his agents or associates to you from January 1, 1999 through December 31, 2002." Whether Jeffrey Epstein paid minor children that he sexually trafficked has absolutely nothing to do with the action before this Court and there is no basis to force a non-party who was subject to this abuse to comply with a production demand on this topic. The subpoena also includes request for financial information relating to the media. Apparently, Defendant believes Jane Doe No. 3 has a book "deal" in the works. For example, Request no. 18 seeks: "All documents concerning any monetary payments or other consideration received by you from any

[2] The requests relevant to this category are nos.: 1, 5, 6,7, 8, 9, 12, 13, 14, 22, and 24.

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media outlet in exchange for your statements (whether "on the record" or "off the record") regarding Jeffrey Epstein, Alan M. Dershowitz, Prince Andrew, Duke of York, and/or being a sex slave." Whether Jane Doe No. 3 has interacted with the media has nothing to do with the Florida Defamation Action. As explained above, a non-party's personal financial information and other confidential information is subject to protection by this Court. *See Woodward v. Berkery*, 714 So. 2d 1027, 1034-38 (Fla. 4th DCA 1998). Accordingly, the requests relating to financial information from this non-party should be quashed[3].

d. Category 4 – Plainly Privileged Communications

Defendant's subpoena requests seek documents that are plainly privileged. Florida courts are unequivocal in stating that an opposing party can never obtain attorney-client privileged materials. *See Quarles & Brady LLP v. Birdsall*, 802 So. 2d 1205, 1206 (Fla. 2d DCA 2002) (quashing discovery order and noting "undue hardship is not an exception (to disclosure of privileged material), nor is disclosure permitted because the opposing party claims that the privileged information is necessary to prove their case.") (internal citations omitted). Non-party, Jane Doe No. 3, objects to all of Defendant's subpoena requests to the extent that they seek documents protected by the attorney client privilege, work product doctrine, joint defense and common interest privileges and any other relevant privilege. Indeed, Jane Doe No. 3 should be protected from responding to Request no. 25 in its entirety because on its face it seeks solely privileged and confidential information relating to her retention of BSF.[4] *See Westco Inc. v. Scott Lewis' Gardening & Trimming, Inc.*, 26 So. 3d 620, 622 (Fla. 4th DCA 2010) (court explaining that "[w]hen confidential information is sought from a non-party, the trial court must determine whether the requesting party establishes a need for the information that outweighs the privacy

[3] These Requests include nos. 9, 17, 18, 20 and 23.

[4] Specifically, Request no. 25 seeks: "All documents concerning your retention of the law firm Boies, Schiller & Flexner LLP, including but not limited to: signed letter of retainer, retention agreement, explanation of fees, and/or any documents describing the scope of retention."

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rights of the non-party."). Defendant has not established any basis for these privileged and confidential documents that outweighs this non-party's privacy rights.

3. The Subpoena Should Be Quashed In Its Entirety. If the Court Will Not Take That Action, at a Minimum, It Should Grant a Protective Order Severely Limiting The Areas Of Inquiry At Deposition And Grant Protections For This Victim Who Is Fearful Of The Defendant.

This Court has the power to preclude and/or limit the deposition of non-party Jane Doe No. 3. Specifically, Florida Rule of Civil Procedure 1.280(c) allows the Court to prevent a deposition from going forward "to protect a party or person from annoyance, embarrassment, oppression or undue burden or expense that justice requires," and courts routinely enter protective orders to reduce the burden on subpoenaed non-parties to a case, as well as in cases where the discovery sough is irrelevant. *See, e.g., Peisach v. Antuna*, 539 So. 2d 544 (Fla. 3d DCA 1989) (holding that the trial judge erred in allowing the deposition of certain non-parties where evidence sought was irrelevant); *see also Citimortgage, Inc. v. Davis*, No. 50 2009 CA 030523, 2011 WL 3360318 (Fla. 15th Cir. Ct. April 4, 2011) (trial court granting protective order precluding a deposition noting "this deposition request is mere harassment" and had no relevance to the underlying dispute where the party was wrongfully using the discovery process for personal gain). Section 4 of Rule 1.280 provides that the Court can also limit the areas of inquiry of a deposition providing "that certain matters not be inquired into, or that the scope be limited to certain matters."

Jane Doe No. 3 contends that the subpoena for her deposition should be quashed. If the Court, however, is inclined to allow a deposition of Jane Doe No. 3, then she respectfully requests the issuance of a Protective Order modifying the subpoena as set forth below.

a. Testimony Limitations

Non-party Jane Doe No. 3 respectfully requests that this Court limit the deposition to questions directly related to Defendant's defamatory statements about Brad Edwards and Paul Cassell. The Court should limit Defendant's ability to engage in a "fishing expedition" of this

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victim to foster his goal of putting her into "jail" or of bringing a new action against Jane Doe No. 3. *See Peisach v. Antuna*, 539 So. 2d 544 (Fla. 3d DCA 1989); *see also Citimortgage, Inc. v. Davis*, No. 50 2009 CA 030523, 2011 WL 3360318 (Fla. 15th Cir. Ct. Apr. 4, 2011). Defendant should be precluded from asking any questions about Jane Doe No. 3's experiences as a sexually trafficked minor. Defendant should be precluded from questioning Jane Doe No. 3 about individuals that she was sexually trafficked to or about other victims or individuals involved in the sexual trafficking orchestrated by Jeffrey Epstein. Defendant should be precluded from questioning Jane Doe No. 3 about any rapes that occurred when she was a minor child. Defendant should be precluded from questioning Jane Doe No. 3 about anything related to her sexual activity either as a minor or thereafter as these questions would only be intended to embarrass and harass this non-party witness.

b. Language and Harassment Limitations

In addition, Jane Doe No. 3 requests that the Court provide counsel with a cautionary notice, that counsel for Defendant may not harass the non-party victim in any way during the deposition. With respect to the language used at the deposition, the Defendant's counsel should be directed by the Court to not use any of the derogatory terms the Defendant has used in the press including calling Jane Doe No. 3 a "prostitute," a "liar," or a "bad mother" or any other similar derogatory and harassing language.

c. Physical Location Limitations

Non-party Jane Doe No. 3 has a valid and real basis to fear being in physical proximity of the Defendant. *See* Exhibit 8, Affidavit of Jane Doe No. 3. Accordingly, to the extent a deposition is to go forward, we would request that the Court direct that the Defendant not be present in the same room as non-party Jane Doe No. 3 and, instead, follow the testimony electronically from a separate location. In addition, non-party Jane Doe No. 3 respectfully requests that the Court hold that the physical location of the deposition should be the offices of

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Jane Doe No. 3's attorney's Boies, Schiller & Flexner LLP.

CONCLUSION

WHEREFORE, non-party Jane Doe No. 3 respectfully requests that this Court grant her Motion to Quash, or alternatively, that the Court enter an order limiting the scope of her document production and deposition as set forth above.

Dated: April 9, 2015

Respectfully submitted,

BOIES, SCHILLER & FLEXNER LLP
401 East Las Olas Boulevard, Suite 1200
Fort Lauderdale, Florida 33301
Telephone: (954) 356-0011
Facsimile: (954) 356-0022

By: /s/Sigrid S. McCawley
Sigrid S. McCawley, Esq.
Florida Bar No. 129305

Attorney for Non-Party Jane Doe No. 3

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CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on April 9, 2015, a true and correct copy of the foregoing was served by Electronic Mail to the individuals identified below.

By: /s/Sigrid S. McCawley
Sigrid S. McCawley

Thomas E. Scott Thomas.scott@csklegal.com Steven R. Safra Steven.safra@csklegal.com COLE, SCOTT & KISSANE, P.A. 9150 S. Dadeland Blvd., Suite 1400 Miami, Florida 33156 Renee.nail@csklegal.com Shelly.zambo@csklegal.com Richard A. Simpson rsimpson@wileyrein.com Mary E. Borja mborja@wileyrein.com Ashley E. Eiler aeiler@wileyrein.com WILEY REIN, LLP 1776 K Street NW Washington, D.C. 20006 *Counsel for Defendant Alan Dershowitz*	Jack Scarola SEARCY DENNEY SCAROLA BARNHART & SHIPLEY, P.A. JSX@searcylaw.com 2139 Palm Beach Lakes Blvd. West Palm Beach, FL 33409-6601 *Attorney for Plaintiffs*

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EXHIBIT B

From: Susan Moss
To: Thomas E. Scott; Steven R. Safra; Simpson, Richard; Borja, Mary; Eiler, Ashley; Jack Scarola; Mary E. Pirrotta; smccawley@bsfllp.com
Subject: Edward & Cassell v. Dershowitz CACE 15-000072 (05)
Date: Wednesday, November 04, 2015 11:22:42 AM

Good morning,

I am advising of Judge Lynch's rulings on the above referenced case. His rulings are as follows:

Non Party's motion to quash, or for protective order, regarding subpoena served on non party law firm Boies Schiller: The subpoena, as to the law firm, is quashed

As to the "Jane Doe #3" subpoena: The motion is granted as to request #9, 17, 18, 20 and 23.

The motion is denied as to the other requests, but a confidentiality order shall be entered.

Regarding the deposition: The depo shall be limited to 4 hours without prejudice to request additional time in the future.

The Defendant can be present at the depo.

The depo will be taken at the law firm representing the witness.

There shall be a special master, paid by the Defendant, present at the depo, to rule on objections.

The depo will be limited to the issues of this case without prejudice for another depo, if required, in the future.

The issues and said limitations will be determined by the special master.

Each attorney who had a motion heard, is to prepare the order on their motion for the judges signature, along with sufficient copies, self addressed, self stamped envelopes for all parties.

These orders cannot be submitted through the order portal.

Respectfully,

Susan Moss
Judicial Assistant to Judge Thomas M. Lynch, IV
201 S.E. 6th Street, Rm 920B
Fort Lauderdale, Florida 33301
954-831-7831

EXHIBIT C

IN THE CIRCUIT COURT OF THE 17TH
JUDICIAL CIRCUIT IN AND FOR
BROWARD COUNTY, FLORIDA

CIVIL DIVISION

BRADLEY J. EDWARDS, and
PAUL G. CASSELL,

Plaintiffs,

v.

ALAN DERSHOWITZ,

Defendant.
_____/

CASE NO. CACE 15-000072

ORDER ON BOIES, SCHILLER & FLEXNER LLP AND JANE DOE NO. 3's MOTIONS TO QUASH SUBPOENAS OR FOR PROTECTIVE ORDER

This Cause comes before the Court on November 2, 2015 upon Boies, Schiller & Flexner LLP's Motion to Quash Subpoena Or For Protective Order and Jane Doe No. 3's Motion to Quash Subpoena Or For Protective Order.

Having reviewed the record and being otherwise fully advised, the Court hereby Orders:

1. Non-Party Law Firm Boies, Schiller & Flexner LLP's Motion to Quash Subpoena is GRANTED. The subpoena to Boies, Schiller & Flexner LLP is quashed in its entirety.
2. Non-Party Jane Doe No. 3's Motion to Quash Subpoena or For Protective Order is Denied in Part, Granted in part, as follows:
    a. The Motion to Quash is Granted as to Requests Nos. 9, 17, 18, 20, and 23. The Motion is denied as to the remaining Requests.
    b. A Confidentiality Order shall be entered.
    c. The deposition of Jane Doe No. 3 shall be limited to 4 hours without prejudice to request for additional time in the future.
    d. The deposition will be taken at the law firm representing the witness, Boies, Schiller & Flexner LLP.

e. There shall be a special master, paid by the Defendant, present at the deposition, to rule on objections.

f. The Defendant Alan Dershowitz can be present at the deposition.

g. The deposition will be limited to the issues of this case without prejudice for another deposition, if required, in the future. The issues and said limitations will be determined by the special master.

DONE AND ORDERED in Broward County, Florida on this ____ day of November, 2015.

THOMAS M. LYNCH, IV

NOV 12 2015

Honorable Judge Thomas Lynch
Circuit Judge

cc: Counsel of Record

EXHIBIT D

IN THE CIRCUIT COURT OF THE 17TH
JUDICIAL CIRCUIT IN AND FOR
BROWARD COUNTY, FLORIDA

CIVIL DIVISION

BRADLEY J. EDWARDS, and
PAUL G. CASSELL,

Plaintiffs,

v.

ALAN DERSHOWITZ,

Defendant.
_____/

CASE NO. CACE 15-000072

[PROPOSED] CONFIDENTIALITY ORDER

THIS CAUSE COMES before the Court based on its Order dated November 12, 2015 granting, in part, Non-Party Jane Doe No. 3's Motion to Quash Subpoena or for a Protective Order. This Court ordered that "A Confidentiality Order Shall Be Entered."

Accordingly, having reviewed the record and being otherwise duly advised, the Court issues the following Confidentiality Order:

1. The deposition testimony of Non-Party Virginia Giuffre will be designated as "Confidential" and not subject to public disclosure. It may only be filed under seal.
2. Documents produced by Non-Party Virginia Giuffre that are confidential may be marked as "Confidential" and shall be treated in the same manner as confidential testimony.

DONE AND ORDERED in Broward County, Florida on this 12 day of January, 2016.

Honorable Judge Thomas Lynch
Circuit Court Judge

cc: Counsel of Record

EXHIBIT E

Filing # 34801581 E-Filed 11/23/2015 05:53:31 PM

IN THE CIRCUIT COURT OF THE SEVENTEENTH JUDICIAL CIRCUIT, IN AND FOR BROWARD COUNTY, FLORIDA

CASE NO.: CACE 15-000072

BRADLEY J. EDWARDS and PAUL G. CASSELL,

Plaintiffs,

vs.

ALAN M. DERSHOWITZ,

Defendant.
_____/

PLAINTIFFS/COUNTERCLAIM DEFENDANT EDWARDS AND CASSELL'S RESPONSE TO DERSHOWITZ'S MOTION TO DETERMINE CONFIDENTIALITY OF COURT RECORDS

Plaintiffs/Counterclaim Defendants Bradley J. Edwards and Paul G. Cassell, by and through their undersigned attorneys, hereby file this response to Dershowitz's Motion to Determine Confidentiality of Court Records. The records at issue are not confidential, and so the Court should deny Dershowitz's motion in its entirety.

The court records at issue are three court filings by attorneys Edwards and Cassell in which they recite their client's (Mr. Virginia Giuffre's) allegations that she was sexually abused by Dershowitz. These records are hardly "confidential" in this defamation case, where the parties have claims and counterclaims about these sexual abuse Allegations. Rather, these records are an important part of this case, since they not only support the conclusion that Dershowitz abused Ms. Giuffre, but also indisputably establish Edwards and Cassell's strong basis for filing the allegations on her behalf. Moreover, contrary to assertions made in Dershowitz's motion, these documents have never been found to be "confidential" by any other court. And Dershowitz has repeatedly referred to

these documents, not only in defamatory statements broadcast worldwide, but also in his pleadings before this Court and in recent depositions. Indeed, Dershowitz said in his media interviews that he wants "everything to be made public" and implied that Edwards and Cassell had something to hide. Accordingly, Dershowitz has failed to carry his heavy burden to justify sealing these presumptively-public documents.

I. DERSHOWITZ HAS NOT JUSTIFIED SEALING ALLEGED DEFAMATORY RECORDS THAT ARE INTEGRAL TO THIS DEFAMATION CASE.

In his motion, Dershowitz never recounts the heavy burden that he must carry to seal the records at issue. To be sure, Florida Rule of Judicial Administration 2.420 allows for the sealing of "confidential" materials. But the Rule begins by recounting the overarching principle that "[t]he public shall have access to all records of the judicial branch of government, except as provided below." Fla. R. Jud. Admin. 2.420(a). This rule is a codification of the Florida Supreme Court's admonition that a "a *strong presumption of openness* exists for all court proceedings. A trial is a public event, and the filed records of court proceedings are public records available for public examination." *Barron v. Florida Freedom Newspapers, Inc.*, 531 So.2d 113, 118 (Fla. 1988) (emphasis added). In light of this presumption of openness, "[t]he burden of proof in [closure] proceedings shall always be on the party seeking closure." *Id.* To obtain a sealing order, the party seeking sealing must carry a "heavy burden." *Id.*

Remarkably, Dershowitz fails to acknowledge these well-settled principles. More important, he even fails to cite (much less discuss) the limited substantive exceptions to this general principle of access – and which specific exception he believes applies to this

case. Accordingly, it is impossible for Edwards and Cassell to respond with precision to his motion.

The exceptions that might arguably be in play in this case permit records to be maintained as confidential in order to:

(i) Prevent a serious and imminent threat to the fair, impartial, and orderly administration of justice;
(ii) Protect trade secrets;
(iii) Protect a compelling governmental interest;
(iv) Obtain evidence to determine legal issues in a case;
(v) Avoid substantial injury to innocent third parties;
(vi) Avoid substantial injury to a party by disclosure of matters protected by a common law or privacy right not generally inherent in the specific type of proceeding sought to be closed;
(vii) Comply with established public policy set forth in the Florida or United States Constitution or statutes or Florida rules or case law . . . .

Fla. R. Jud. Admin. 2.420(c)(9) (codifying the holding in *Barron v. Florida Freedom Newspapers, Inc.*, 531 So.2d 113 (Fla. 1988)). The only exception that seems to even arguably apply here is exception vi, which itself specifically provides that confidentiality is appropriate only where disclosure is "*not generally inherent* in the specific type of proceeding sought to be closed" (emphasis added). Of course, this lawsuit is a defamation action – involving a defamation claim by Edwards and Cassell and a defamation counterclaim by Dershowitz. Disclosure, discussion, and debate about the defamatory statements at issue lies at the heart of the case. Accordingly, disclosure of these materials is "inherent" in the case itself. The principle that defamatory material in a defamation case cannot be sealed is recognized in *Carnegie v. Tedder*, 698 So.2d 1310 (2d DCA 1997). *Carnegie* involved a claim and counterclaim between two parties (Carnegie and Tedder), one of whom alleged that disclosure of

the materials in the records would be harmful to his professional reputation. *Carnegie* recited subsection vi's restriction on release of materials involving a privacy right, but noted that "statements Tedder alleged were defamatory and damaging were allegations in Carnegie's counterclaim for which she seeks damages. These matters were not peripheral to the lawsuit; they were inherent to it." *Id.* at 1312. Of course, exactly the same principle applies here: sexual abuse allegations filed by attorneys Edwards and Cassell for their client Ms. Virginia Giuffre are not peripheral to this lawsuit – they are inherent to it.

To see how "inherent" the sexual abuse allegations are to this lawsuit, the Court need look no further than Dershowitz's counterclaim in this case. Count I of Dershowitz's Counterclaim (styled as "False Allegations in the Joinder Motion") contends that Edwards and Cassell should pay him damages because they "filed a pleading in the Federal Action titled 'Jane Doe #3 and Jane Doe #4's Motion Pursuant to Rule 21 for Joinder in Action' . . . ." Dershowitz Counterclaim at ¶ 14. Dershowitz's Counterclaim then goes on to quote at length from the Joinder Motion. His counterclaim contains, for example, this paragraph recounting the allegations:

> The Joinder Motion then goes on to allege – without any supporting evidence – as follows:
>
> > One such powerful individual that Epstein forced then-minor Jane Doe #3 to have sexual relations with was former Harvard Law Professor Alan Dershowitz, a close friend of Epstein's and well-known criminal defense attorney. Epstein required Jane Doe #3 to have sexual relations with Dershowitz on numerous occasions while she was a minor, not only in Florida but also on private planes, in New York, New Mexico, and the U.S. Virgin

> Islands. In addition to being a participant in the abuse of Jane Doe #3 and other minors, Dershowitz was an eye-witness to the sexual abuse of many other minors by Epstein and several of Epstein's coconspirators. Dershowitz would later play a significant role in negotiating the [Non-Prosecution Agreement] on Epstein's behalf. Indeed, Dershowitz helped negotiate an agreement that provided immunity from federal prosecution in the Southern District of Florida not only to Epstein, but also to "any potential coconspirators of Epstein." Thus, Dershowitz helped negotiate an agreement with a provision that provided protection for himself against criminal prosecution in Florida for sexually abusing Jane Doe #3. Because this broad immunity wouldhave been controversial if disclosed, Dershowitz (along with other members of Epstein's defense team) and the Government tried to keep the immunity provision secret from all of Epstein's victims and the general public, even though such secrecy violated the Crime Victims' Rights Act.

Dershowitz Counterclaim at ¶ 15 (quoting Joinder Motion at 4).

Remarkably, having quoted at length from the Joinder Motion in his Counterclaim in this case, Dershowitz now seeks to have *that very same language* from the Joinder Motion deemed "confidential" and sealed. *Compare* Counterclaim at ¶15 (block quotation above) with Motion to Determine Confidentiality, Exhibit A at 4 (composite exhibit with proposed "confidential" document that includes paragraph beginning "[o]ne such powerful individual that Epstein forced then-minor Jane Doe #3 to have sexual relations with was former Harvard Law Professor Alan Dershowitz, a close friend of Epstein's . . . ."). Dershowitz cannot come before this Court and file a counterclaim seeking damages from Edwards and Cassell for alleged defamatory statements and then ask to have those very same statements placed under seal as "confidential." *See Barron v. Florida Freedom Newspapers*, 531 So.2d at 119 ("although generally protected by one's privacy right, medical reports and history are no longer protected

when the medical condition becomes an integral part of the civil proceeding, *particularly when the condition is asserted as an issue by the party seeking closure*" (emphasis added)).

II. JUDGE MARRA'S ORDER IN HIS CASE DOES NOT REQUIRE THAT THE RECORDS BE SEALED IN THIS CASE.

Dershowitz also appears to contend that Judge Marra's order striking some of the materials from the records at issue somehow requires that these stricken materials be kept confidential in this case. Dershowitz's argument misunderstands both the scope of Judge Marra's order and its effect in this case. His argument rests on a truncated – and misleading -- description of the events surrounding Judge Marra's ruling striking certain documents. A more complete description makes clear that Judge Marra has not determined the documents are somehow "confidential" even in the federal Crime Victims' Rights Act case – much less in this separate state defamation action.

Edwards and Cassell filed the federal case pro bono on behalf of two young women who were sexually abused as underage girls by Dershowitz's close personal friend – Jeffrey Epstein. In 2008, Edwards and Casell filed a petition to enforce the rights of "Jane Doe No. 1" and "Jane Doe No. 2" under the Crime Victims' Rights Act (CVRA), 18 U.S.C. § 3771, alleging that the Government had failed to provide them rights with regard to a plea arrangement it was pursuing with Epstein. *Jane Doe No. 1 and Jane Doe No. 2 v. United States*, No. 9:08-cv-80736 (S.D. Fla.). In the course of that case, on October 11, 2011, the victims filed discovery requests with the Government, including requests specifically seeking information about Dershowitz, Prince Andrew, and others. Further efforts from the Government to avoid any discovery

followed (*see generally* Docket Entry or "DE" 225-1 at 4-5), ultimately leading to a further Court ruling in June 2013 that the Government should produce documents. DE 189. The Government then produced about 1,500 pages of largely irrelevant materials to the victims (DE 225-1 at 5), while simultaneously submitting 14,825 pages of relevant materials under seal to the Court. The Government claimed that these pages were "privileged" for various reasons, attaching an abbreviated privilege log.

While these discovery issues were pending, in the summer of 2014, Edwards and Cassell, contacted Government counsel to request their agreement to add two additional victims to the case, including Ms. Virginia Giuffre (who was identified in court pleadings as "Jane Doe No. 3"). Edwards and Cassell sought to have her added to the case via stipulation, which would have avoided the need to include any detailed facts about her abuse. Weeks went by and the Government – as it had done on a similar request for a stipulation to add another victim – did not respond to counsel's request for a stipulation. Finally, on December 10, 2014, despite having had four months to provide a position, the Government responded by email to counsel that it was seeking more time, indicating that the Government understood that victims' counsel might need to file a motion with the court on the matter immediately. DE 291 at 3-5. Rather than file a motion immediately, victims' counsel waited and continued to press the Government for a stipulation. *See id.* at 5. Finally, on December 23, 2014 – more than four months after the initial request for a stipulated joinder into the case – the Government tersely indicated its objection, without indicating any reason: "Our position is that we oppose adding new petitioners at this stage of the litigation." *See* DE 291 at 5.

Because the Government now contested the joinder motion, Edwards and Cassell prepared a more detailed pleading explaining the justification for granting the motion. One week after receiving the Government's objection, on December 30, 2014, Ms. Giuffre (i.e., Jane Doe No. 3) and Jane Doe No. 4 filed a motion (and later a corrected motion) seeking to join the case. DE 279 and DE 280. (Note: DE 280 is the first of the three documents Dershowitz seeks to have declared "confidential" in this case.) Uncertain as to the basis for the Government's objection, the motion briefly proffered the circumstances that would qualify the two women as "victims" eligible to assert rights under the CVRA. *See* 18 U.S.C. 3771(e) (defining "crime victim" protected under the Act). With regard to Ms. Giuffre, the motion indicated that when she was a minor, Jeffrey Epstein had trafficked her to Dershowitz and Prince Andrew (among others) for sexual purposes. Jane Doe No. 3 stated that she was prepared to prove her proffer. *See* DE 280 at 3 ("If allowed to join this action, Jane Doe No. 3 would prove the following . . . . "). The motion also provided specific reasons why Jane Doe No. 3's participation was relevant to the case, including the pending discovery issues regarding Dershowitz and Prince Andrew. DE 280 at 9-10 (explaining several reasons participation of new victims was relevant to existing issues).

After the motion was filed, various news organizations published articles about it. Dershowitz also made numerous media statements about the filing, including calling Jane Doe No. 3 "a serial liar" who "has lied through her teeth about many world leaders." http://www.cnn.com/2015/01/06/us/dershowitz-sex-allegation/. Dershowitz also repeatedly called Edwards and Cassell "two sleazy, unprofessional, disbarable lawyers." *Id.* On

January 5, 2015, Dershowitz filed a motion to intervene to argue to have the allegations stricken. DE 282. Dershowitz also argued that Ms. Giuffre had not provided a sworn affidavit attesting to the truth of her allegations. On January 21, 2015, Edwards and Cassell filed a response for Ms. Giuffre and Jane Doe No. 4. DE 291. (Note: This is the second of the three documents Dershowitz seeks to have kept under seal here.) The response enumerated nine specific reasons why Ms. Giuffre's specific allegations against Dershowitz were relevant to the case, including the fact that Ms. Giuffre needed to establish that she was a "victim" in the case, that pending discovery requests concerning Dershowitz-specific documents were pending, and that Dershowitz's role as a defense attorney in the case was highly relevant to the motive for the Government and defense counsel to conceal the plea deal from the victims. DE 291 at 17-26 & n.17. The response included a detailed affidavit from Ms. Giuffre about the sexual abuse she had suffered from Epstein, Dershowitz, and other powerful persons. DE 291-1. On February 6, 2015, Edwards and Cassell filed a further pleading (and affidavit from Ms. Giuffre, *see* DE 291-1) in support of her motion to intervene. (Note: this affidavit is the third of the three documents Dershowitz seeks to have declared confidential.)

On April 7, 2015, Judge Marra denied Ms. Giuffre's motion to join the case. Judge Marra concluded that "at this juncture in the proceedings" details about the sexual abuse she had suffered was unnecessary to making a determination "of whether Jane Doe 3 and Jane Doe 4 should be permitted to join [the other victims'] claim that *the Government* violated their rights under the CVRA. The factual details regarding with whom and where the Jane Does engaged in sexual activities are impertinent to this central claim (i.e., that they were known victims of Mr.

Epstein and the Government owed them CVRA duties), especially considering that the details involve non-parties who are not related to the respondent Government." DE 324 at 5 (emphasis in original). While Judge Marra struck those allegations, he emphasized that "Jane Doe 3 is free to reassert these factual details through proper evidentiary proof, should [the victims] demonstrate a good faith basis for believing that such details are pertinent to a matter presented for the Court's consideration. Judge Marra then denied Ms. Giuffre's motion to join the case, but allowed her to participate as trial witness: "The necessary 'participation' of [Ms. Giuffre] . . . in this case can be satisfied by offering . . . properly supported – and relevant, admissible, and non-cumulative – testimony as needed, whether through testimony at trial . . . or affidavits supported in support [of] the relevancy of discovery requests." DE 324 at 8 (emphasis deleted). In a supplemental order, Judge Marra stated that the victims "may re-refile these documents omitting the stricken portions." DE 325. The victims have recently refiled the documents.

In light of this history, Dershowitz is flatly incorrect when he asserts that "Judge Marra's Order appropriately precludes the unredacted documents from being re-filed in this case on the public docket." Confidentiality Motion at 3. To the contrary, the Order specifically permits factual details about Dershowitz's sexual abuse of Ms. Giuffre to be presented in regard to pertinent matters in the *federal CVRA case*. And certainly nothing in Judge Marra's Order could render those documents confidential in *this state defamation* case, where the central issues swirl around Edwards and Cassell's good faith basis for filing the allegations. Indeed, the order is not binding in any way in this case, because it is res judicata only as to Ms. Giuffre (the moving

party in that case), not as to her attorneys Edwards and Cassell. *See Palm AFC Holdings, Inc. v. Palm Beach County*, 807 So.2d 703 (4th DCA 2002) ("In order for res judicata to apply four identities must be present: (1) identity of the thing sued for; (2) identity of the cause of action; (3) identity of persons and parties; and (4) identity of the quality or capacity of the persons for or against whom the claim is made.").

III. EDWARDS AND CASSELL WILL BE PREJUDICED IF THEY ARE BARRED FROM QUOTING FROM THE RECORD WHILE DERSHOWITZ IS PERMITTED TO FREELY REFER TO THEM WHENEVER HE FINDS IT CONVENIENT.

Dershowitz is also incorrect when he asserts that no prejudice will befall Edwards and Cassell if the records are placed under seal. To the contrary, placing the documents under seal would permit Dershowitz to continue to misrepresent and distort what is contained in those records while preventing Edwards and Cassell from correcting those misrepresentations. Dershowitz has repeatedly referred to details in the records when he has found it convenient to do so – treating the records as not confidential in any away. One clear example comes from Dershowitz's recent deposition, where he gratuitously injected into the record a reference to a portion of Ms. Giuffre's affidavit about him watching Ms. Giuffre perform oral sex on Epstein. And then, having injected that gratuitous reference into the record, he proceeded to try to rebut the reference with confidential settlement discussions – but did so by mispresenting what another attorney (David Boies) had said during the settlement discussions. So that the Court may have the full flavor of the exchange, the narrow question to Dershowitz (by attorney Jack

Scarola) and Dershowitz's extended answer are quoted in full – including Dershowitz's reference to the oral sex allegation that he now argues this Court should treat as "confidential":

> Q. [Y]ou [are] aware that years before December of 2014, when the CVRA pleading was filed, that your name had come up repeatedly in connection with Jeffrey Epstein's abuse of minors, correct? . . .
>
> A. Let me answer that question. I am aware that never before 2014, end of December, was it ever, ever alleged that I had acted in any way inappropriately with regard to Virginia [Giuffre], that I ever touched her, that I ever met her, that Ihad ever been with her. I was completely aware of that. There had never been any allegation. She claims under oath that she told you that secretly in 2011, but you have produced no notes of any such conversation. You, of course, are a witness to this allegation and will be deposed as a witness to this allegation. I believe it is an entirely false allegation that she told you in 2011 that she had had any sexual contact with me. I think she's lying through her teeth when she says that. And I doubt that your notes will reveal any such information.
> But if she did tell you that, she would be absolutely, categorically lying. So I am completely aware that never, until the lies were put in a legal pleading at the end of December 2014, it was never alleged that I had any sexual contact with Virginia Roberts.
> I know that it was alleged that I was a witness to Jeffrey Epstein's alleged abuse and that was false. I was never a witness to any of Jeffrey Epstein's sexual abuse. And I wrote that to you, something that you have falsely denied. And I stand on the record. The record is clear that I have categorically denied I was ever a witness to any abuse, that I ever saw Jeffrey Epstein abusing anybody.
>
> *And -- and the very idea that I would stand and talk to Jeffrey Epstein while he was receiving oral sex from Virginia Roberts, which she swore to under oath, is so outrageous, so preposterous, that even David Boies said he couldn't believe it was true.*
>
> MS. McCAWLEY: I object. I object. I'm not going to allow you to reveal any conversations that happened in the context of a settlement discussion.
>
> THE WITNESS: Does she have standing?

> MS. McCAWLEY: I have a standing objection and, I'm objecting again. I'm not going to
>
> THE WITNESS: No, no, no. Does she have standing in this deposition?
>
> MR. SCOTT: Let's take a break for a minute, okay?
>
> THE WITNESS: I'm not sure she has standing.
>
> MR. SCAROLA: Are we finished with the speech?
>
> MR. SCOTT: No. If he --
>
> MR. SCAROLA: I'd like him to finish the speech so that we can get to my question
> and then we can take a break.
>
> A. So the question -- the answer to your question is --
>
> MR. SIMPSON: Wait a minute. Wait a minute. Wait a minute. Please don't disclose something that she has a right to raise that objection if she wants to.
>
> MR. SCOTT: Exactly.

Deposition of Alan Dershowitz (Oct. 15, 2015) at 93-95 (attached as Exhibit 1); *see also* Deposition of Alan Dershowitz (Oct. 16, 2016) (attached as Exhibit 2) (also containing discussion of Ms. Giuffre's affidavit).

The Court should be aware that within approximately two hours of this exchange, Ms. McCawley (David Boies' law partner) released a statement on his behalf, which stated that Dershowitz was misrepresenting what happened: "Because the discussions that Mr. Boies had with Mr. Dershowitz were expressly privileged settlement discussions, Mr. Boies will not, at least at this time, describe what was actually said. However, Mr. Boies does state that Mr.

Dershowitz description of what was said is not true." Statement of Ms. McCawley on Behalf of David Boies (Oct. 15, 2015).

More broadly, the Court can readily see from this passage how Dershowitz is willing to inject into the record a part of Ms. Giuffre's affidavit whenever it serves his purpose – and, indeed, to characterize the part of the affidavit as "preposterous." But then he asks this Court to place the underlying affidavit under seal, so that the Edwards and Cassell stand accused having filed a "preposterous" affidavit without anyone being able to assess the validity of Dershowitz's attack.

Dershowitz has referred to the court records that he now wishes to have the Court declare confidential not only in his deposition, but also in his widely-broadcast media attacks on Edwards and Cassell. For example, Dershowitz appeared on the British Broadcasting Corporation (the BBC) and was asked about the allegations:

> Well, first of all they were made in *court papers* that they don't even ask for a hearing to try to prove them. They put them in *court papers* in order to immunize themselves from any consequences from a defamation suit. *The story is totally made up,* completely out of whole cloth.
> I don't know this woman. I was not at the places at the times. It is part of a pattern of made up stories against prominent people and world leaders. And the lawyers in recent statement challenged me to deny the allegations under oath. I am doing that. I am denying them under oath, thus subjecting me to a perjury prosecution were I not telling the truth. *I am now challenging them to have their client put these charges under oath* and for them to put them under oath. I am also challenging them to repeat them outside of the context of court papers so that I can sue them for defamation. . . . And I will prove beyond any doubt not only that the story is totally false, but it was knowingly false: that the lawyers and the client *conspired together to create a false story*. That is why I am moving for their disbarment in challenges to be provided to the disciplinary committee.

BBC Radio 4 - Sarah Montague (Jan. 3, 2015) (http://www.bbc.co.uk/programmes/p02g7qbc).

Similarly, Dershowitz appeared on NBC's *Today Show* the morning after Edwards and Cassell made a filing for Ms. Giuffre, to say that the Edwards and Cassell – and Ms. Giuffre – were all "lying" in the court documents:

> Question from Savannah Guthrie: *In legal papers from the lawyers*, they say you've had, in fact, the opportunity to be deposed.
>
> Answer from Alan Dershowitz: They're lying. They're lying.
>
> Question: They show letters in which they offered to depose you.
>
> Answer: And they didn't show my letters in response saying, (a), if you ask me about my legal relationship with Epstein and I'll be happy to answer. . . . And I responded that I would be happy to be deposed if you could give me any indication that I would be a relevant witness . . . . They will be proved – all of them [i.e., Cassell, Edwards, and Ms. Giuffre] – to be categorically lying and *making up this story.* And it will be a terrible thing for rape victims. . . . We [Epstein and Dershowitz] had an academic relationship. I was never in the presence of a single, young, underaged woman. When I was with him, it was with prominent scientists, prominent academics. And they're just – again – lying about this. I never saw him doing anything improper. I was not a participant. I was not a witness.

Today Show, Jan. 22, 2015 (emphases added).

As another example, in *Miami Herald*, Dershowitz called the Joinder Motion that he seeks to have sealed "the sleaziest *legal document* I have ever seen. They [Edwards and Cassell] manipulated a young, suggestible woman who was interested in money. This is a disbarrable offense, and they will be disbarred. They will rue the day they ever made this false charge against me" – i.e., Edwards and Cassell will "rue the day" they ever filed the Joinder Motion. *Miami Herald* (Jan. 3, 2015).

Most remarkably, Dershowitz took the public airwaves to represent that he wanted all of the information surrounding the allegations to "be made public," while implying that Edwards and Cassell had something to hide. For example, on the BBC he claimed that he wanted"everything to be made public":

> Q: Would you encourage that it now be made public?
>
> A: Of course, of course. *I want everything to be made public. I want every bit of evidence in this case to be made public. I want every allegation to be made public.* I want to know who else she's accused of these horrible crimes. We know that she accused Bill Clinton of being on Jeffrey Epstein's island and participating in sex orgy with underage girls. The records of the Secret Service will prove that President Clinton never set foot on that island. So that she lied. Now it's possible to have a case of mistaken identification with somebody like me. It's impossible to have a case of mistaken identification with Bill Clinton.
> My only feeling is that if she has lied about me, which I know to an absolute certainty she has, she should not be believed about anyone else. She's lied clearly about me, she's lied clearly about Bill Clinton. We know that. We know that she's lied about other public figures, including a former prime minister and others who she claims to have participated in sexual activities with. So I think it must be presumed that all of her allegations against Prince Andrew are false as well.
> I think he [Prince Andrew] should clear the air as well.
> If you're squeaky clean and if you have never done anything like this, you must fight back with all the resources available to you. And that's what I will do. I will not rest or stop until the world understands no only that I had nothing to do with any of this, but that she deliberately, with the connivance of her lawyer, lawyers, made up this story willfully and knowingly.

BBC Radio 4 - Sarah Montague (Jan. 3, 2015) (http://www.bbc.co.uk/programmes/p02g7qbc).

In another widely-broadcast interview on CNN, Dershowitz implied that there is no evidence supporting the allegations against him:

> *Ask them [Edwards and Cassell] if they have any evidence . . . .* They're doing it for money. She's getting money for having sold her story. She wants to sell the book. They're trying to get into this lawsuit. They see a pot of gold at the end of the rainbow. They're [Edwards and Cassell] prepared to lie, cheat, and steal. These are unethical lawyers. This is Professor Cassell who shouldn't be allowed near a student. This is Professor Cassell, who is a former federal judge, thank God he no longer wears a robe. He is essentially a crook. He is essentially somebody who's distorted the legal profession. . . . Why would he charge a person with a sterling reputation for 50 years on the basis of the word alone of a woman who is serial liar, who has lied about former Prime Ministers, former Presidents, has lied demonstrably.

CNN Live (with Hala Gorani) (January 5, 2015). Of course, by placing "the evidence" in this case under seal, Dershowitz will be free to continue to try and insinuate that Edward and Cassell – and their client, Ms. Giuffre – had no evidence supporting the allegations against him, even though a mountain evidence strongly support Ms. Giuffre's allegations. See Deposition of Paul Cassell (Oct. 16, 2015) at 61-117 (Exhibit 3); see also Depo of Pual Cassell (Oct. 17, 2015) (Exhibit 4).

CONCLUSION

The Court should deny Defendant/Counterclaim Plaintiff Alan Dershowitz's motion to place documents regarding Ms. Giuffre's allegations against him under seal.

I HEREBY CERTIFY that a true and correct copy of the foregoing was sent via E-Serve to all Counsel on the attached list, this 23rd day of November, 2015.

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Prince Andrew and the 17-year-old girl his sex offender friend flew to Britain to meet him

By SHARON CHURCHER
UPDATED: 08:02 EST, 2 March 2011

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- **She describes being flown across world to meet Prince Andrew**
- **Epstein trained her 'as a prostitute for him and his friends'**

As the UK's special representative for international trade, the Duke of York holds an important position, requiring sound judgement and widespread respect.

But those qualities have been thrown into question since photographs of Prince Andrew with his billionaire financier friend Jeffrey Epstein, a convicted child-sex offender who was jailed for 18 months for soliciting underage prostitutes, appeared last weekend.

Today, however, even more serious doubts are cast on his suitability after a woman at the centre of the Epstein case revealed to The Mail on Sunday that she had, as a 17-year-old employed by Epstein, been flown across the world to be introduced to the Prince.

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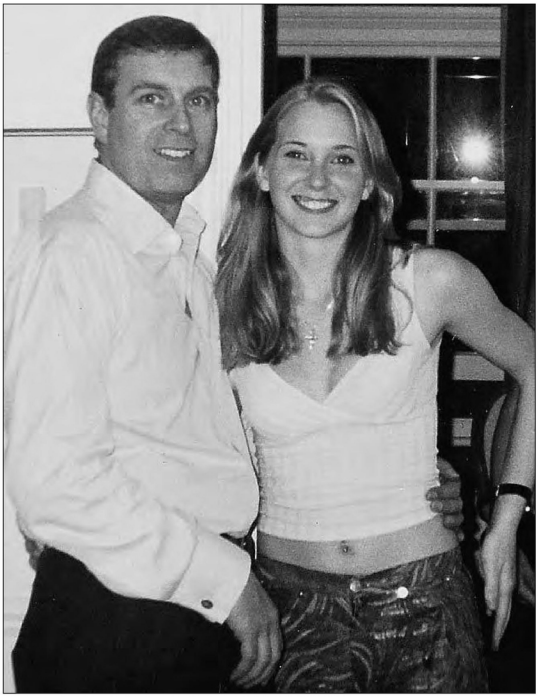

First meeting: Prince Andrew puts his arms around 17-year-old Virginia, centre

On one of those occasions Virginia Roberts was subsequently paid $15,000 (£9,400). Her shocking account of her four years as Epstein's personal masseuse is supported by court documents, an eyewitness, photographs and flight details of Epstein's private jets.

One picture, said to have been taken by Epstein during Andrew's first encounter with the girl in March 2001 and published today by The Mail on Sunday, shows the Prince with his arm around her waist.

This is not the first time the Duke of York's judgment and choice of associates have been questioned. He appears to relish the company of super-rich oil billionaires from the Middle East, North Africa and the former Soviet Union.

The peculiar sale of his former marital home to a Kazakh businessman for £15 million after it had languished unsold for five years at £12 million has never been satisfactorily explained.

In the recent leak of American diplomatic cables it was revealed that he had criticised an official corruption investigation into the huge Al-Yamamah arms deal between Britain and Saudi Arabia, while he is also said to be close to Saif Al-Islam Gaddafi, son of the beleaguered Libyan president, and may have had a role in the early release of Lockerbie bomber Abdelbaset Al Megrahi.

But it is Andrew's friendship with Epstein, whom he has known since at least 2000, and with Epstein's confidante Ghislaine Maxwell, daughter of the late disgraced newspaper baron Robert Maxwell, that gives most concern.

While on the streets, I slept with men for money. I was a paedophile's dream

He was first seen with the pair on holiday in Thailand, and was pictured cavorting with Ghislaine at a Halloween fetishthemed party in Manhattan.

The photograph that appeared last weekend shows the prince strolling through Central Park with 58-year-old Epstein. Andrew was said to have spent four days at his New York mansion in December, when he was joined by other distinguished guests, including Woody Allen, at a dinner.

It is by no means the first New York soiree Andrew has attended as Epstein's guest.

A lengthy profile of the financier in Vanity Fair magazine some years ago reported that Andrew was a guest at a cocktail party thrown by Epstein and Maxwell packed with young Russian models. 'Some guests were horrified,' said the article's author, Vicky Ward.

It should not be forgotten that Epstein is a registered sex offender after recently completing his sentence for offences relating to child prostitution.

announce they are expecting a baby boy - after trying to get pregnant for more than a year

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However, he avoided trial on more serious charges that carried a potential life sentence. And no one reading The Mail on Sunday's interview with the woman who was prepared to testify against him can be in any doubt of the seriousness of the charges.

Epstein, a Wall Street money manager who once counted Bill Clinton and Donald Trump among his friends, became the subject of an undercover investigation in 2005 after the stepmother of a 14-year old girl claimed she was paid $200 (£125) to give him an 'erotic massage'.

The subsequent FBI probe uncovered at least 20 girls levelling sexual allegations against him. Eventually, Epstein struck a 'plea bargain' with prosecutors – a practice not permitted under British law – under which he was allowed to plead guilty to two relatively minor charges.

Police claim that his donations to politicians and his 'dream team' of influential lawyers deterred prosecutors from bringing more serious charges of sex-trafficking. The deal certainly kept the names of a lot of Epstein's famous friends out of an embarrassing court case.

However, an unusual part of the agreement was that Epstein's alleged victims were allowed to bring civil proceedings against him.

He has so far made 17 out-of-court settlements, and some cases are ongoing. One of these girls was to have been a key witness for the prosecution had the case gone to trial. She was just 15 years old when she was drawn into Epstein's exploitative world in 1998.

In her civil writ against him, under the pseudonym Jane Doe 102' she alleged that her duties included being 'sexually exploited by Epstein's adult male peers including royalty'.

Now, horrified by the evidence of Epstein and Andrew enjoying each other's company in New York, Jane Doe 102 has agreed to waive her anonymity and tell for the first time her deeply disturbing story.

Her real name is Virginia Roberts and she now lives in Australia, where she is a happily married mother of three.

Over the course of a week during which she spoke at length to The Mail on Sunday, she appeared sometimes vulnerable, and sometimes steely, but always quietly resolute and consistent.

Revisiting events from a past that she had hoped she had left behind,Virginia occasionally buried her face in her hands.

Some recollections – and, for reasons of taste, not all the details can be included here – caused her to flush with shame. 'I'm telling you things that even my husband didn't know,' she said.

Virginia, who has undergone counselling to try to come to terms with her past, is honest about her initiation into Epstein's depraved world.

She was a troubled teenager, whose slender figure, delicate complexion, hesitant voice and soulful blue eyes made her look young for her years.

Born in Sacramento, California, in August 1983, Virginia spent her early years on a small ranch on the West Coast of America.

This seemingly idyllic childhood ended when she was sexually molested by a man close to her family.

The fallout from that led to her parents temporarily splitting up. Blaming herself, Virginia began to get into trouble Aged 11, she was sent to live with an aunt but repeatedly ran away.

Living on the streets, she was beaten up and slept with at least two older men in return for food. 'I was a paedophile's dream,' she says.

Three years later, she was reunited with her family and started a new life with her father who had moved to Palm Beach,

Florida, where he was maintenance manager at Donald Trump's country club, Mar-a-Lago.

Virginia got a part-time job as a changing room assistant –which is where, soon after her 15th birthday, she met Ghislaine Maxwell, who invited her to work as Epstein's personal masseuse.

A new life: Virgina, now a mother-of-three, in Australia

'I was wearing my uniform – a white miniskirt and a skin-tight white polo top – when I was approached by Ghislaine,' Virginia says.

'I told her I wanted to become a masseuse and she said she worked for a very wealthy gentleman who was looking for a travelling masseuse.

I'd get training and be paid well.'Virginia's father gave his blessing, believing his daughter was being handed the opportunity to learn a skill and to work for a wealthy and respectable employer.

He drove her to Epstein's pink mansion on the Palm Beach waterfront – he also owns a nine-storey home in New York, the city's biggest private residence; a 7,500-acre ranch called 'Zorro' in New Mexico and Little Saint James, a private 70- acre atoll in the US Virgin Islands.

Virginia says: 'Ghislaine said I was to start immediately and that someone would drive me home.

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After 19 years together

'I'm happier taking my clothes off!' Heidi Klum strips to her underwear... but reveals she suffers stage fright on live TV
Supermodel is now 42

'Time to move on': Ariel Winter hints at split with boyfriend Laurent Gaudette after two PDA-filled years
Last photographed together in November

'I wouldn't have put me on the show either': Gigi Hadid says she was 'shaking' during unsuccessful first Victoria's Secret audition

Who's that boy? Kate Hudson looks chuffed as she steps out with mystery man in New York City
The 36-year-old has been playing the field

What a sweet couple! Pregnant Ginnifer Goodwin shares a kiss with husband Josh Dallas while eating ice cream at Disneyland
Happiest place on earth

Kendall Jenner showcases her lithe legs in leather jeans as she jets out of London 'on her way to visit baby Saint in Los Angeles'
Off to meet her nephew

Penelope Cruz puts her ample cleavage and curvaceous figure on display in clinging red leather jumpsuit in new Zoolander 2 posters
Stars in the sequel

HOUSE_OVERSIGHT_015645

My father left and I was told to go upstairs.' She was led by another woman through Epstein's bedroom into a massage room where he lay face down naked on a table.

He started to interviewed Virginia. This was unconventional, but Virginia had no suspicions. Presumably, she thought, this was how the wealthy conducted their business.

Epstein elicited the information that Virginia had been a runaway, and was no longer a virgin.

Virginia was then told to start massaging Epstein, under the instructions of the woman who had shown her in. The massage quickly developed into a sexual encounter.

Virginia was uncomfortable, but reluctant to deny such important people. 'My face was red with embarrassment,' she says. 'But I felt under immense pressure to please them.

The whole time it was going on, they were promising me the world, that I'd travel with Jeffrey on his private jet and have a well-paid profession.' Afterwards, she was given two $100 bills and told to return the next day.

That was the beginning of the four years she spent with Epstein.

For three of those years, she was under Florida's age of consent, which is 18.

Troubled teenager: Virginia on the billionaire's Zorro ranch in New Mexico in 2001

Virginia was fascinated by his life story: the son of a humble New York City parks worker, he was a teacher before becoming a Wall Street broker and friends with the upper echelons of the political, financial and academic establishment.

As a confused teenager, Virginia easily fell into the practice of sexually gratifying him for money.

He guaranteed her a minimum of $200 each time she gave him what he called an 'erotic massage.'

Virginia said: 'I would always receive the money immediately. He would give me the cash from a wad he carried in a black duffel bag or an assistant paid me.

'And, because of the way Epstein had warped her sensibilities, every time she took the cash, Virginia felt even more indebted to him. Secretly, he was also preparing her for an even more disturbing role.

'Basically, I was training to be a prostitute for him and his friends who shared his interest in young girls,' she says: 'After about two years, he started to ask me to "entertain" his friends.'

Epstein had trained me to do whatever men wanted. I told myself I was special

It started when Epstein called Virginia at the Palm Beach apartment he had rented for her.

She recalls: 'He said, "I've got a good friend and I need you to fly to the island to entertain him, massage him and make him feel how you make me feel."

He didn't spell out what I had to do. He didn't have to. 'He'd trained me to do whatever a man wanted. I was shocked but I told myself he was sharing me around because he trusted me and I was special.

I was worried, but I would do anything to keep Jeffrey happy and to keep my place as his number one girl.

He would keep telling me how lucky I was with the life I was leading and the money I was making. It was easy to fall into his grasp.

'The way it usually worked was I'd be sent to meet a man on the private island Jeffrey owned in the Caribbean, or at his ranch in New Mexico, which was really isolated.' She was 'given' to men ranging in age from their 40s to their 60s.

They included a well-known businessman (whose pregnant wife was asleep in the next room), a world-renowned scientist, a respected liberal politician and a foreign head of state.

None appeared to think the arrangement was unusual. Virginia says there were many other girls in Epstein's circle and that she was paid extra money to help recruit them.

'They would lounge around the Palm Beach house, the ranch or the island, nude or topless,' she says. 'But I was one of the very few he trusted as "special" and chosen to "entertain" his friends.'

Virginia took the sedative Xanax to detach herself from sordid reality. 'It was an escape drug,' she says. 'It made me calm and helped me forget about what I had to do. I was up to eight pills a day.'

Epstein had no objection to Virginia's use of prescription drugs, no doubt recognising that they made her even more malleable. 'I didn't want to go back to the life I'd had before' she says.

'That made me totally obedient.' Despite the fact that Epstein was, essentially, her pimp, this life now seemed normal to Virginia. 'I felt that he and Ghislaine really cared for me,' she said.

The Hunger Games may have prequels as Lionsgate promises the franchise 'will live on and on'
Lionsgate is exploring the possibilities

'My funny honey': Christie Brinkley promotes her 17-year-old daughter Sailor's modeling career with some bikini snaps on Instagram

'She's doing great!': Kim Kardashian's BFF Jonathan Cheban gives update on Saint's mother as he gets cheeky with bikini-clad girlfriend in Miami

Jimmy Kimmel makes up fake baby names for Kim and Kanye's son during Lie Witness News segment
Spok in his segment Lie-Witness News

Victoria's Secret Angel Lily Aldridge reveals her husband doesn't want their daughter 'anywhere near the runway' but insists she would proud

Androgynous model challenges Victoria's Secret's beauty standards by posing in the brand's lingerie and then editing the faces of Angels onto her body

Hey Baby! Abigail Breslin signs on to star in Dirty Dancing TV musical
The iconic 1987 movie famously starred Jennifer Grey

Emma Watson cuts a chic figure with knitted jumpsuit as she attends screening of ethical fashion documentary in London
Harry Potter star

Yolanda Foster's estranged husband David 'blames' Real Housewives show for 'ruining his reputation' and the failure of his record company

'I can handle myself': New Star Wars: The Force Awakens trailer shows Daisy Ridley trying to put Harrison Ford in his place
Highly anticipated film

HOUSE_OVERSIGHT_015646

'We'd do family things, like watch Sex And The City and eat popcorn. 'A lot of it was very glamorous. I met famous friends of his such as Al Gore and Heidi Klum and Naomi Campbell. He introduced me as his "travelling masseuse."

Some people mistook me for his daughter. 'When we were in New York or Palm Beach, Ghislaine and I would shop all day.

Jeffrey bought me jewellery – diamonds were his favourite – and wonderful furniture. He was paying me very well because I'd give him sex whenever he wanted it.'

She was, she says, delighted when Epstein invited her to accompany him on a six-week trip in 2001.

'He said we'd be going to Europe and North Africa to meet architects and interior decorators because he wanted to redo his New Mexico house.

I threw my arms around him and gave him a peck on the cheek.' They flew to Paris, then Spain, then Tangier.

Finally, they went to London. 'After we landed, we drove straight to Ghislaine's house,' says Virginia. 'I was given a small upstairs bedroom. The following morning, Ghislaine came in.

Counselling: Virginia at her mother's home at Palm Beach in 1998

She was chirpy and jumped on the bed saying, "Get up, sleepyhead. You've got a big day. We've got to go shopping. You need a dress as you're going to dance with a Prince tonight."

'She said I needed to be "smiley" and bubbly because he was the Queen's son.

Ghislaine and I went to Burberry, where she bought me a £5,000 bag, and to a few other designer stores where we bought a couple of dresses, a pair of embroidered jeans and a pink singlet, perfume and make-up.

We got back to Ghislaine's house at around 4pm and I ran straight upstairs to shower and dress.

When I went downstairs, Ghislaine and Jeffrey were in the lounge. There was a knock at the door. Ghislaine led Andrew in and we kissed each other on the cheek. 'Ghislaine served tea from a porcelain pot and biscuits. She knew Sarah Ferguson and they talked fondly about Andrew's daughters.

Then Ghislaine asked Andrew how old he thought I was and he guessed 17 and they all laughed. Ghislaine made a joke that I was getting too old for Jeffrey.

She said, "He'll soon have to trade her in." It was widely known that he liked young girls.' The four of them went out to dinner and on to Tramp nightclub where, she says, Andrew danced with her.

'After about an hour-and-a-half, we drove back to Ghislaine's.

All of us went upstairs and I asked Jeffrey to snap a picture of me with the Prince. I wanted something to show my Mom. Ghislaine and Jeffrey left us after that, and later Andrew left.

'In the morning, Ghislaine said, "You did well. He had fun". We flew straight back to the States.' The Mail on Sunday has confirmed that the tycoon's jet flew to Paris on March 6, 2001, continuing to Granada, Tangier and London, before returning to New York.

On the last leg of the trip, Virginia was paid about $15,000 (£9,400) by Epstein. 'It was amazing money, more than I'd ever made on a trip with him before.

He didn't say there was any special reason, but I felt like I'd done everything he wanted. He was very pleased.'

There is no suggestion that there was any sexual contact between Virginia and Andrew, or that Andrew knew that Epstein paid her to have sex with his friends.

I took eight pills a day to help me forget what I had to do. It made me calm.

However, the Prince must have been aware of Epstein's conviction when he stayed with him in New York in December.

Virginia says she met Andrew for a second time around Easter 2001 at Epstein's Manhattan mansion.

'When I got to the mansion, I was told, "Get ready. You are meeting someone in the office" – which is what they called the library. Andrew was sitting there in a big leather armchair.

Ghislaine had just given him a present, a big toy that was his Spitting Image puppet. 'He was smiling ear-to-ear. He looked like a kid whose parents were taking him to Disney World.

A beautiful girl called Johanna Sjoberg who worked for Jeffrey was sitting on Andrew's knee. Ghislaine guided me over to Andrew and I think he recognised me, though I don't know if he remembered my name.

'He was so excited': Star Wars' Adam Driver gushes about 'surreal' experience of working with 'generous' Harrison Ford on Force Awakens Co-starred with a legend

Alicia Vikander wows in strapless embellished gown as she hits the red carpet for The Danish Girl premiere in London The 27-year-old actress ignored chilly weather

Eddie Redmayne is feeling festive in another plaid suit as wife Hannah Bagshaw stuns in sheer dress at London premiere of The Danish Girl

On their way home! Kim Kardashian and Kanye West 'have left the hospital with baby son Saint' three days after welcoming him into the world

'I can't deal with it!' Kate Gosselin horrified as her 15-year-old twin girls start talking to boys in sneak peek for upcoming season of reality show

'They lost their father years ago': Scott Weiland's ex-wife pens letter on behalf of his two children asking people not to glorify the tragedy

Welcome to the Hollywood hall of fame! Andy Garcia's daughter Alessandra lands plus-size modelling career and stars in sultry lingerie shoot

'He doesn't deserve that kind of treatment': Burt Reynolds wades in on Angelina Jolie's tumultuous relationship with father Jon Voight Spoke on UK TV show

Arnold Schwarzenegger launches epic rant against climate change deniers saying he 'doesn't give a damn' about what people think

Ka-ching! Katy Perry conquers rival Taylor Swift as the top-earning musician of 2015 Forbes examined the pre-tax income, including endorsements

'Loyalty sometimes bites you in the a**': Gigi Hadid gets frank about exes, BFF Kendall Jenner and being a protective big sister to Bella

Leggy Gigi Hadid is a color co-ordinated dream in all-nude outfit as she showcases supermodel stems in slashed jumpsuit Stepped out in New York

Kendall Jenner reads

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Organiser: Ghislaine Maxwell looks on as Andrew put his arm around Virginia. Robert Maxwell's daughter invited her to work as Epstein's personal masseuse soon after her 15th birthday

We kissed on the cheek and Ghislaine placed me on his other knee.' Johanna spoke to The Mail on Sunday three years ago about this incident, which took place when she was 21.

She said: 'Ghislaine put the puppet's hand on Virginia's breast, then Andrew put his hand on my breast. It was a great joke. Everybody laughed.' After this, Virginia was paid, by Epstein, around $400 (£250).'

She met Andrew for the third and final time on Epstein's Caribbean island, Little Saint James. Virginia was never under the British legal age of consent when she met Andrew. She was 17 during the first two encounters and 18 at the third.

By now, however, Epstein, had started to hint that she was getting 'too old' for him.

But during one trip to the island, Epstein and Ghislaine made their most astonishing proposition, and one which repulsed her. 'They said Jeffrey wanted me to have his child,' she says.

'They said I was part of their family and I was beautiful,young, loyal and nurturing and would be a great mother.

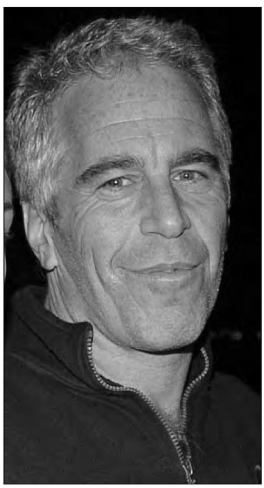
They said I would have to sign a contract relinquishing rights to the child and consenting to Jeffrey having as many relationships as he liked. In return I would have my own mansion in Palm Beach and a large monthly payment, a percentage of his income.'

This, finally, was a wake-up call to Virginia and she began to see the way in which she had been groomed.

'It was a smack in the face,' she says, 'I finally realised this wasn't ever going to be a real relationship but I knew if I refused, I'd be thrown back on the streets. So I said, "I'm too young. I want to get my massage credentials, then maybe we'll do it".'

The tycoon took her at her word and, for her 19th birthday in August 2002, flew her to Thailand where he enrolled her in a massage course.

Shortly after arriving there, she met an Australian martial arts expert called Robert. They fell in love and, just ten days later, married in a Buddhist ceremony.



Conviction: Jeffrey Epstein

'I called Jeffrey and told him I'd fallen madly in love,' Virginia says. 'I was hoping he'd be delighted. But he said, "Have a nice life," and hung up on me.' The couple now have two sons, aged five and four, and a daughter who recently turned one.

comments on social media until she sees mean one... and admits modelling career started because 'I wanted to prove them wrong'

Victoria Beckham shows off her svelte figure in head to toe black in NY... as David shares cute snap of Harper during daddy daughter day in the UK

'You have to set boundaries': Khloe Kardashian says working out is a priority as she heads to the gym in tight exercise gear
She's a gym junkie

'Forever grateful': Kim Zolciak gets into the Christmas spirit as she takes her six children to meet Santa Claus
The 37-year-old shared sweet family photos

Emily Ratajkowski shows off her ample assets as she writhes around in sheer lingerie for LOVE's festive advent calendar
Blurred Lines model

'I had sex with two women': The Affair star Joshua Jackson reveals awkward post-work conversations with partner Diane Kruger
All in a day's work

'Mostly he says nein!': Claire Danes reveals son Cyrus speaks German after attending Kindergarten in Berlin while she filmed Homeland

Selena Gomez and Niall Horan continue to fuel romance rumors as they're spotted enjoying a date night at Santa Monica Pier
Look away Justin Bieber

Prince Harry's ex Cressida Bonas appears to go TOPLESS as she poses in velvet gloves and diamonds for high-end French fashion magazine L'Officiel

He's really Gonna! Blake Shelton performs single about pursuing new love in front of girlfriend Gwen Stefani on The Voice
Romantic gesture

Christina Milian flashes her flat stomach in a glitzy crop top and skinny jeans as she parties with pal Vanessa Simmons
Dip It Low singer

Lindsay Lohan shows off her figure in sexy bikini and platform heels as she lies back on a

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'The first few months after I married Robert were the worst,' she says. 'I couldn't bring myself to tell him much. No man wants to know his wife has been traded out.

'I felt very alone. I was having panic attacks and seeing a psychiatrist and was on anti-depressants.

' Virginia was beginning to put her Epstein days behind her when, three years ago, she was phoned by the FBI.

'They said they had found photos of me at Jeffrey's Palm Beach house,' she says. '[Epstein had] hidden cameras watching me the entire time even when I was in the bathroom. I was so embarrassed.

'I told the FBI that my true purpose was sexual. They told me everything he did was illegal because I was under age.' (The age of consent in Florida is 18).

'They said that if it had to go to trial, they'd need me because I'd lived with him and that made me a key witness. I was very afraid, because he had so much power, but eventually I agreed to testify.

I was glad he'd finally been found out. He shouldn't be hurting other girls. Following Epstein's arrest, investigators are believed to have found a list of men's names on his computer and asked him whether they had been 'treated' to sexual encounters with his menage of minors.

'He took the Fifth Amendment, refusing to answer, indicating that if he were to answer the question, it could be incriminating,' a source told The Mail on Sunday.

Epstein struck a deal resulting in what commentators characterised as a 'slap on the wrist' for him, and ended up serving 13 months of his sentence, much of it in a liberal work-release programme Lawyer Brad Edwards, who represented several of Epstein's victims, said: 'Rather than punish him the way they would an average Joe, they sent a clear message that with enough money and power and influence, the system can be bought.'

Virginia was spared her the humiliation of having to go before a jury, and has kept her feelings bottled up until last weekend's photograph of Andrew with Epstein triggered distressing memories.

Virginia says: 'I am appalled. To me, it's saying, "We are above the law." But Jeffrey is a monster.'

Last night, neither Epstein, Ghislaine Maxwell nor Prince Andrew would comment on Virginia's story.

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She plays Dr. Robbins

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Name was criticized

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Expecting first child

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Daughter of Demi Moore and Bruce Willis

'Seems I'm an absolute pleasure to shoot': Amy Schumer shares sexy behind-the-scenes look at her Pirelli Calendar photo session
She's in the 43rd edition

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IN THE CIRCUIT COURT OF THE 17th
JUDICIAL CIRCUIT IN AND FOR
BROWARD COUNTY, FLORIDA

CIVIL DIVISION

BRADLEY J. EDWARDS, and
PAUL G. CASSELL,

Plaintiffs,

v.

ALAN DERSHOWITZ,

Defendant.
_____/

CASE NO. CACE 15-000072

RESPONSE TO DEFENDANT ALAN DERSHOWITZ'S MOTION FOR CLARIFICATION OF CONFIDENTIALITY ORDER OR RELIEF FROM THAT ORDER

Non-Party Virginia Giuffre, by and through undersigned counsel, hereby responds to Defendant Alan Dershowitz's Motion for Clarification of Confidentiality Order or Relief From that Order and states as follows:

FACTUAL BACKGROUND

On November 12, 2015 this Court issued an Order granting in part, non-party Virginia Giuffre's Motion to Quash the subpoena served by Defendant Alan Dershowitz and ordered protective limits relating to her deposition. *See* Exhibit A, November 12, 2015 Order. On December 18, 2016, this Court entered a Confidentiality Order holding that non-party Virginia Giuffre's deposition would be confidential. *See* Exhibit B, December 18, 2015 Confidentiality Order. On January 16, 2016, Ms. Giuffre testified at her deposition in accordance with this Court's Order. The deposition was labelled confidential in accordance with this Court's Order. As the Court knows, Ms. Giuffre was a victim of sexual trafficking when she was a minor child. Indeed, the U.S. Attorney's Office for the Southern District of Florida has specifically recognized

her as a "victim" of federal sex offenses. Unsurprisingly, her deposition contains highly sensitive information about her experiences as a minor child, including detail descriptions of sexual crimes committed against her.

ARGUMENT

1. Non-Party Virginia Giuffre Agrees That Her Deposition Should Be Provided Confidentially To Law Enforcement to Investigate All The Crimes Committed Against Her

Defendant Dershowitz seeks to have the Court grant an exception to the confidential nature of the deposition so that it can be provided to the Office of the State Attorney and the Office of the United States Attorney for investigative purposes. Specifically, Defendant Dershowitz states in his motion that he is hoping to have law enforcement investigate whether Ms. Giuffre committed perjury by stating in her previously filed affidavit that it is her recollection that she witnessed former President Bill Clinton on Jeffrey Epstein's island in the United States Virgin Islands ("USVI")[1].

Setting aside Defendant Dershowitz's baseless claims of perjury, Ms. Giuffre agrees that her confidential deposition should be provided to law enforcement, including the United States Attorney and the State Attorney in each jurisdiction where any alleged crimes occurred so that they may investigate all of the crimes committed against her when she was a minor child. To ensure that justice is served and that Defendant Dershowitz's request is not just another charade designed only to bully a sexual abuse victim, Ms. Giuffre asks the Court to impose the following reasonable conditions relating to the disclosure:

- Mr. Dershowitz agrees and is directed to cooperate with authorities and answer all questions relating to the investigation of crimes against Ms. Giuffre.

[1] Defendant Dershowitz conveniently ignores that publicly available flight logs of Jeffrey Epstein's private planes demonstrate that President Clinton travelled with Jeffrey Epstein and others to various locations throughout the world including Europe, Africa and Asia. *See* Exhibit C, Excerpts of Flight Logs from Jeffrey Epstein's private plane.

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- Mr. Dershowitz agrees to make his client, Jeffrey Epstein, and others with relevant testimony and with whom he has testified he shares a "common interest" – at least Epstein and Maxwell – available to any law enforcement agency reviewing any alleged criminal activities; or in the alternative, to attest to this Court that those necessary witnesses have consented to full cooperation in the investigation Mr. Dershowitz is seeking permission to initiate.

- Mr. Dershowitz agrees to waive the statute of limitations in all jurisdictions for any criminal conduct he participated in or was aware of relating to Ms. Giuffre so that law enforcement can pursue any necessary charges. Defendant Dershowitz proclaimed that he was willing to waive any statute of limitation for criminal conduct so this should not be an issue. *See* Exhibit D, January 12, 2016 Deposition Transcript of Alan Dershowitz at 395. "I had talked about the statute of limitations for criminal purpose was what I said, that I would waive the statute of limitations for criminal purposes."

- Mr. Dershowitz agrees to provide the names and contact information for each State Attorney and United States Attorney for which he has or is planning to provide information relating to Ms. Giuffre; and agrees to jointly, with Ms. Giuffre's counsel, request that the State Attorney and United States Attorney, in the relevant jurisdictions, investigate all potential criminal conduct. Both parties may provide any relevant information they have that may assist the authorities with their investigation.

- For all other purposes non-party Ms. Giuffre's January 16, 2016 deposition transcript shall remain confidential and sealed other than for confidential disclosure to law enforcement as described above.

2. Mr. Dershowitz Has No "Evidence" of Perjury And Instead Is Simply Trying To Bully This Victim

As explained above, Defendant Dershowitz wrongly suggests to this Court that non-party Virginia Giuffre has committed perjury in an effort to taint the Court against this victim. His only "evidence" of this alleged perjury is a self-serving opinion from his retained expert that an "absence of records" in response to a FOIA request, establishes that former President Clinton was never on Jeffrey Epstein's island in the USVI. Defendant Dershowitz misrepresents the government's response. The government is only required to conduct a reasonable search of readily accessible records. Accordingly, an "absence of records" response does not mean that records do not exist. It simply means that in the course of the search, no records were found. *See Cunningham v. U.S. Dept. of Justice*, 961 F.Supp. 2d 226, 236 (D.C. 2013) (court reasoning that "[t]he adequacy of a search is measured by a standard of reasonableness… The question is not

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whether other responsive records may exist, but whether the search was adequate."); *Wilbur v. C.I.A.*, 355 F.3d 675, 678 (D.C. 2004) (court explaining that "the agency's failure to turn up a particular document, or mere speculation that as yet uncovered documents might exist, does not undermine the determination that the agency conducted an adequate search for the requested records."). Moreover, when dealing with a former President's security detail travel, there are a number of reasons why the government may not disclose those records.

As explained above, public flight records from Jeffrey Epstein's private plane show that President Clinton traveled with Jeffrey Epstein on multiple occasions. Nevertheless, if Defendant Dershowitz wants to pursue this issue before the Court, then he needs to produce for deposition testimony in this case and the proposed criminal investigation, the other witnesses that were present on the island at the time former President Clinton was alleged to have visited, including his client Jeffrey Epstein, and Ghislaine Maxwell, to whom he has testified he is party to a joint defense agreement. It is worth noting on that point, that despite Mr. Epstein's counsel's attendance at depositions in this case, and Defendant Dershowitz's claim that Mr. Epstein is still his client, Mr. Epstein has taken extreme measures to avoid being deposed in this case despite being ordered to deposition by this Court.

Indeed, it is also noteworthy that during Defendant Dershowitz's recent deposition, counsel for Mr. Edwards and Mr. Cassell asked Defendant Dershowitz the following question: "Was Virginia Roberts lying when she said Jeffrey Epstein socialized with Bill Clinton during the relevant time period?" Depo Tr. Of Alan Dershowitz, Vol. 4, January 12, 2016 at 511. Before Defendant Dershowitz could answer, Mr. Dershowitz's legal counsel interposed an attorney-client privilege objection. *Id.* Perhaps Mr. Epstein's defense counsel can provide to the Court an appropriate privilege log regarding that objection – and all the communications between Mr. Epstein and Defendant Dershowitz that would have been revealed in answer to that question – so that the Court will have the benefit of a full record in ruling on this motion.

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CONCLUSION

WHEREFORE, Non-Party Virginia Giuffre respectfully requests that this Court allow a limited release of her confidential deposition transcript to law enforcement subject to the terms set forth above on pages 2-3.

Dated: February 8, 2016

Respectfully submitted,

BOIES, SCHILLER & FLEXNER LLP
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By: /s/Sigrid S. McCawley
Sigrid S. McCawley, Esq.
Florida Bar No. 129305

Attorney for Non-Party Virginia Giuffre

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CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on February 8, 2016, a true and correct copy of the foregoing was served by Electronic Mail to the individuals identified below.

By: /s/Sigrid S. McCawley
Sigrid S. McCawley

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EXHIBIT A

IN THE CIRCUIT COURT OF THE 17TH
JUDICIAL CIRCUIT IN AND FOR
BROWARD COUNTY, FLORIDA

CIVIL DIVISION

BRADLEY J. EDWARDS, and
PAUL G. CASSELL,

Plaintiffs,

v.

ALAN DERSHOWITZ,

Defendant.

CASE NO. CACE 15-000072

_____/

ORDER ON BOIES, SCHILLER & FLEXNER LLP AND JANE DOE NO. 3's MOTIONS TO QUASH SUBPOENAS OR FOR PROTECTIVE ORDER

This Cause comes before the Court on November 2, 2015 upon Boies, Schiller & Flexner LLP's Motion to Quash Subpoena Or For Protective Order and Jane Doe No. 3's Motion to Quash Subpoena Or For Protective Order.

Having reviewed the record and being otherwise fully advised, the Court hereby Orders:

1. Non-Party Law Firm Boies, Schiller & Flexner LLP's Motion to Quash Subpoena is GRANTED. The subpoena to Boies, Schiller & Flexner LLP is quashed in its entirety.
2. Non-Party Jane Doe No. 3's Motion to Quash Subpoena or For Protective Order is Denied in Part, Granted in part, as follows:
    a. The Motion to Quash is Granted as to Requests Nos. 9, 17, 18, 20, and 23. The Motion is denied as to the remaining Requests.
    b. A Confidentiality Order shall be entered.
    c. The deposition of Jane Doe No. 3 shall be limited to 4 hours without prejudice to request for additional time in the future.
    d. The deposition will be taken at the law firm representing the witness, Boies, Schiller & Flexner LLP.

e. There shall be a special master, paid by the Defendant, present at the deposition, to rule on objections.

f. The Defendant Alan Dershowitz can be present at the deposition.

g. The deposition will be limited to the issues of this case without prejudice for another deposition, if required, in the future. The issues and said limitations will be determined by the special master.

DONE AND ORDERED in Broward County, Florida on this ____ day of November, 2015.

THOMAS M. LYNCH, IV

N / 1 2 2015

Honorable Judge Thomas Lynch
Circuit Judge

cc: Counsel of Record

EXHIBIT B

IN THE CIRCUIT COURT OF THE 17TH
JUDICIAL CIRCUIT IN AND FOR
BROWARD COUNTY, FLORIDA

CIVIL DIVISION

BRADLEY J. EDWARDS, and
PAUL G. CASSELL,

Plaintiffs,

v.

ALAN DERSHOWITZ,

Defendant.

CASE NO. CACE 15-000072

/

ORDER ON BOIES, SCHILLER & FLEXNER LLP'S MOTION TO SEAL

This Cause comes before the Court on December 18, 2015 upon Boies, Schiller & Flexner LLP's Motion to Seal "Exhibit B, Affidavit of Alan M. Dershowitz Regarding Meetings with David Boies" to Defendant Alan M. Dershowitz's Motion in Limine to Overrule Objections As to Application of Settlement Rules, Filing # 35429605 E-Filed 12/11/2015 at 10:08:04 a.m.

Having reviewed the record and being otherwise fully advised, the Court hereby Orders:

the motion to seal is granted.

DONE AND ORDERED in Broward County, Florida on this 18 day of December, 2015.

THOMAS M. LYNCH, II
DEC 18 2015
TRUE COPY

Honorable Judge Thomas Lynch
Circuit Court Judge

cc: Counsel of Record

EXHIBIT C

Date	Aircraft Make and Model	Aircraft Identification Mark	Points of Departure & Arrival: From	To	Miles Flown	Flight No.	Remarks, Procedures, Maneuvers, Endorsements	Number of Landings	Aircraft Category: Airplane	Glider	Helicopter
~~10~~ 2002 JAN 21	N908GM	C-421B	PBI	FXE			D.O. AT BROWARD AVIATION TO HAVE ENDORS SET UP	1/1	6		
MAY 11	N908JC	B-727-31	PBI	JFK		93	JC, SK	1/1	2 5		
11	B-727-31	N908JC	JFK	LFPB		94	JC, GM, SK	/1	7 2		
13	"	"	LFPB	LFPG		95	REPOSITION		5		
13	"	"	LFPG	EGGW		96	JC, GM, SK		8		
16	"	"	EGGW	LFMN		97	JC, GM, SK	1/1	1 8		
19	"	"	LFMN	UNNT		98	JC, GM, SK	1/	6 7		
20	"	"	UNNT	RJTA		99	JC, GM, SK	/1	6 5		
22	"	"	RJTA	VHHH		100	JC, GM, SK, PRESIDENT BILL CLINTON, MEXL, DOUG BANDS, JANICE, JESSICA PETE RASHGGB		4 0		
23	"	"	VHHH	ZGSZ		101	SAME AS ABOVE PETE RASHGGB		4		
23	"	"	ZGSZ	WSSS		102	SAME AS ABOVE PETE RASHGGB		3 4		
25	"	"	WSSS	VTBD		103	SAME AS ABOVE PETE RASHGGB		2 2		
25	"	"	VTBD	WBSB		104	SAME AS ABOVE PETE RASHGGB		2 6		
27	"	"	WBSB	WRRR		105	JC, GM, SK PETE RASHGGB	1/1	2 1		
29	"	"	WRRR	VCBI		106	JC, GM, SK PETE RASHGGB		5 2		
29	"	"	VCBI	OMDB		107	JC, GM, SK PETE RASHGGB		4 4		
30	"	"	OMDB	LFPB		108	JC, GM, SK PETE RASHGGB		3 8		
31	"	"	LFPB	EGGW		109	JC, GM, SK PETE RASHGGB	1/1	1 0		
JUN 7	"	"	EGGW	EIDW		110	REPOSITION		1 7		
							Page Total	6/7	57 4		
							Amount Forward	6533 2180	8635 1	3 5	112 6
							Total to Date	6539 6187	8692 5	3 3	112 6

I certify that the statements made by me on this form are true.

Pilot's Signature David Rodgers

HOUSE_OVERSIGHT_015662

Date	Aircraft Make and Model	Aircraft Identification Mark	Points of Departure & Arrival: From	To	Miles Flown	Flight No.	Remarks, Procedures, Maneuvers, Endorsements	Number of Landings	Aircraft Category: AIRPLAN	GLIDER	HELICOP
~~19~~ 2002 FEB 18	B-727-31	N908JC	PBI	ABY		64	BM, SK, GLEN DUBIN, 2 FEMALES RICHARD COOK	1/	1 3		
18	"	"	ABY	JFK		65	JG, GM, SK, GLEN DUBIN, 2 FEMALE RICHARD COOK		2 1		
20	"	"	JFK	MRY		66	JG, SK, GERALDINE LAYBOURNE, KIT LAYBOURNE, STEVEN PARKER, NINA & SAM ZAGAT	1/	5 9		
~~23~~	"	"	~~MRY~~	~~VNY~~			DAVID ROCKWELL, CAROLYN MILLER, MICHAEL WOLF, DANIEL DENNIGIT, RICHARD COOK				
23	"	"	MRY	VNY		67	JOHN BROCKMAN, KARENA MATSON, CINDY KELLY BOVENA, 6 OTHER PASSENGERS	1/	8		
23	"	"	VNY	JAX		68	JG, SK, KELLY BOVENA, NINA & SAM ZAGAT, B CHECK FAA, EMERGENCY RAMP, PROCEDURES		4 2		
25	G-1159B	N908JC	~~TGB~~ PBI	~~ABQ~~ TGB		1661	LARRY MORRISSEY SK, T & L LANDING ROGER, SLOANE & SPENCER BARNETTE, ARLENE (NANNY)	1/	2 5		
25	"	"	TGB	ABQ		1662	GM	1/	4 3		
28	B-727-31	N908JC	JAX	PBI		71	B CHECK	1/	1 2		
MAR 6	B-727-200	SIMULATOR	MIA	MIA			STEEP TURN, STALLS, HOLDING,		2 0		
7	"	"	"	"			EMERGENCY DESCENT, RTO, UNUSUAL ATTITUDES, ENGINE FAILURES, MISSED APPROACH		2 0		
7	"	"	"	"			EMERGENCY DESCENTS, 2 ENGINES OUT, WINDS ALOFT, HYDRAULIC FAILURES		2 0		
8	"	"	"	"			EMERGENCY DESCENT, HOLDING, ENGINE FAIL, WHEEL WELL FIRE		2 0		
10	B-727-31	N908JC	TIST	JFK		72	JG, GM, SK, AP, CINDY, 2 FEMALES	1/	4 1		
14	"	"	JFK	PBI		73	JG, SK, JOE PAGANO, JULIE, TODD		2 5		
17	"	"	PBI	JFK		74	JG, SK, JOE PAGANO, JULIE, TODD, 1 FEMALE	1/	2 6		
19	"	"	JFK	EGGW		75	BILL CLINTON, DOUG BAND, 3 SECRET SERVICE		6 7		
21	"	"	EGGW	JFK		76	JG, GM, SK BILL CLINTON, DOUG BAND, 10 SECRET SERVICE	1	7 8		
22	"	"	JFK	PBI		77	JG, GM, SK, NAOMI CAMPBELL, 1 MALE SERVICE FOR GM		2 6		
							Page Total	~~85~~ 6	56 6		
							Amount Forward	6517 6169	8541 9	3 3	112 6
							Total to Date	6526 6175	8549 5	3 3	112 6

I certify that the statements made by me on this form are true.

Pilot's Signature David Ridgeway

HOUSE_OVERSIGHT_015663

Date 19 2002	Aircraft Make and Model	Aircraft Identification Mark	Points of Departure & Arrival From	To	Miles Flown	Flight No.	Remarks, Procedures, Maneuvers, Endorsements	Number of Landings	Aircraft Category... Airplane	Glider	Helicopter
JUL 13	B-727-314	N908JC	LFMN	GMTT		120	JC, GM, SK, AP, CINDY LOPEZ		2 1		
13	"	"	GMTT	GMMC		121	JC, GM, SK, CL, AP		7		
13	"	"	GMMC	LPAZ		122	JC, GM, SK, AP, CL, PRESIDENT CLINTON DOUG BANDS, MIKE, & SECRET SERVICE		2 4		
13	"	"	LPAZ	JFK		123	JC, GM, SK, AP, CL, PRESIDENT BILL CLINTON, DOUG BAND, MIKE, & SECRET SERVICE		5 8		
18	"	"	JFK	PBI		124	JC, SHELLEY LEWIS, 2 FEMALES		2 2		
19	"	"	PBI	JAX		125	KRISTY RODGERS, GREG HOUBURT, ALYSSA HALBERT - C CHECK		1 0		
AUG 4	G-1159B	N909JC	PBI	MVY		1583	JC, 1 FEMALE		2 8		
4	"	"	MVY	BED		1584	JC, 1 FEMALE		7		
4	"	"	BED	TEB		1585	JC, 1 FEMALE		9		
5	"	"	TEB	SAF		1586	JC, SK, 2 FEMALES	1/1	3 9		
6	C-172XP	N7394P	ACG	ACG			172 CHECK OUT	3/3	9		
6	206L3	N474AW	ZORRO	ACG							
15	B-727-314	N908JC	JAX	JAX		126	C-CHECK FLIGHT TEST PCTE RATINGS	1/1	9		
16	"	"	JAX	PBI		127	RETURN FROM C-CHECK PCTE RATINGS		1 1		
17	G-1159-B	N909JC	SAF	TEB		1589	JC, GM, SK, CINDY LOPEZ, VIRGINIA ROBERTS, DAN MALONE CONTARDO, ALFRED, MARGARITA, NICK SEMMES,		3 7		
18	"	"	TEB	PBI		1590	JC, VIRGINIA ROBERTS, 1 FEMALE		2 4		
21	B-727-314	N908JC	PBI	TEST		128	JC, SHELLEY LEWIS		2 5		
25	"	"	TEST	JFK		129	JC, SK	1/1	3 6		
28	"	"	JFK	LFPB		130	JC, SK, CINDY LOPEZ, 1 FEMALE		6 4		
							Page Total	6/6	44 0		5
							Amount Forward	6547 6194	8140 1	3 3	112 6
							Total to Date	6553 6200	8184 1	3 3	113 1

I certify that the statements made by me on this form are true.

Pilot's Signature David Rodgers

HOUSE_OVERSIGHT_015664

Date ~~19~~ 2002	Aircraft Make and Model	Aircraft Identification Mark	Points of Departure & Arrival: From	To	Miles Flown	Flight No.	Remarks, Procedures, Maneuvers, Endorsements	Number of Landings	Aircraft Category... Airplane	Glider	Helicopter
31	B-727-31H	N908JC	LFPB	EGBB		131	JC, NICOLE JUNKERMANN	1/1	1 0		
SEP 2	"	"	EGBB	LFPB		132	JC, NICOLE JUNKERMANN		1 0		
3	"	"	LFPB	JFK		133	JC, SK, CINDY LOPEZ, JEAN LUC BRUNEL	1/1	7 5		
4	"	"	JFK	PBI		134	JC, 1 FEMALE		2 5		
8	G-1159B	N909JC	PBI	TEB		1592	JC, ANDREA, 2 FEMALES		2 7		
9	G-1159B	"	TEB	BED		1593	JC, SHELLEY LEWIS	1/1	9		
9	"	"	BED	TEB		1594	JC, SHELLEY LEWIS		9		
10	"	"	TEB	TIST		1595	JC, SHELLEY LEWIS, ANDREA JANLE		3 8		
15	"	"	TIST	PBI		1596	JC, SK, DIANE FLEETWOOD				
21	B-727-31H	N908JC	JFK	LPAZ		136	PRESIDENT WILLIAM J. CLINTON, KEVIN SPACEY, CHRIS TUCKER JC, GM,	1/1	2 6		
22	"	"	LPAZ	DGAA		137	SK, CL, CHAUNTAE DAVIES, ANDREA MISROVICH DOUG BANG, DAVID SLACK, JIM KENNEDY	1/0	5 2		
23	"	"	DGAA	DNAA		138	ERIC NUNES, RONNY SLATER, CASEY FLANIGAN WASSERMAN, RON BURKLE, CLAYE SMITH	1/1	5 7		
24	"	"	DNAA	HRYR		139	SAME AS ABOVE LESS RON BURKLE	0/	1 7		
25	"	"	HRYR	FQMA		140	SAME AS ABOVE PLUS ERA MAGAZINER		4 0		
26	"	"	FQMA	FACT		141	SAME AS ABOVE		3 0		
27	"	"	FACT	FAJS		142	SAME AS ABOVE LESS JC, GM, SK, CL CHAUNTAE DAVIES, ANDREA MISROVICH	1/	2 4		
28	"	"	FAJS	FACT		143	SAME AS ABOVE LESS CLAYE SMITH, ERA MAGAZINER		2 1		
29	"	"	FACT	DGAA		144	SAME AS ABOVE ADD JC, GM, SK, CL CD, AM		2 0		
29	"	"	DGAA	LFPB		145	SAME AS ABOVE		6 2		
								/1	6 5		
							Page Total	5/6	62 5		
							Amount Forward	6553 6200	8784 1	3 3	1 3 1
							Total to Date	6558 6206	8846 6	3 3	1 3 1

I certify that the statements made by me on this form are true.

Pilot's Signature David Rodgers

HOUSE_OVERSIGHT_015665

Date -19- 2002	Aircraft Make and Model	Aircraft Identification Mark	Points of Departure & Arrival: From	To	Miles Flown	Flight No.	Remarks, Procedures, Maneuvers, Endorsements	Number of Landings	Aircraft Category... AIRPLANE	GLIDER	HELICOPTER
29	B-727-314	N909JE	LFPB	EGGW		146	SAME AS ABOVE LESS JE, SK, CD, LONDA KRASCH WASSERMAN	1/1		9	
OCT 1	"	"	EGGW	LFPB		147	GM, NICK & EDWENS SIMMONDS				
2	"	"	LFPB	JFK		148	JE, GM, SK, CL, ANDREA METROVICH, NADINE CAMPBELL		1	0	
3	"	"	JFK	PBI		149	JE, SK, ANDREA METROVICH, NICK SIMMONDS, CHGE, LEGMALE		8	1	
6	G-1159B	N409JE	PBI	TEB		1387	JE, SK, ANDREA, RYAN, EDWARD		2	4	
11	"	"	TEB	PBI		1388	JE, GM, ANDREA, RYAN, GLAN		2	3	
14	"	"	PBI-OPF-PBI			1599	MARK POSTER - PPC ILS SINGLE ENGINE & GO AROUND SE	1/1	2	5	
15	"	"	PBI	TEB		1600	JE, GM, ANDREA METROVICH, RYAN DIONNE	1/1		8	
17	"	"	TEB	TIST		1601	JE, SK, ANDREA METROVICH		2	4	
21	"	"	TIST	PBI		1602	JE, SK, AM ANNA HANKS, JULIETTE BRYANT	1/1	3	7	
30	"	SIMULATOR	JFK	MIV			SKIP TAKEOFF, STALL, SLOW FLIGHT, REJECTED TAKEOFF, HOLDING, SINGLE ENGINE APPROACH AND TRAINING EMERGENCY PROCEDURES, ELEVATOR, EMERGENCY DESCENT, SINGLE ENGINE APPROACH, NORMAL LANDING GEAR, CIRCLING APPROACH	3/3	2	6	
31	"	"	MIV	JFK					2	0	
NOV 3	"	"	SWF	JFK					2	4	
6	B-727-200	N909JE	PBI	TIST		1603	JE, SK, ANDREA METROVICH		2	6	
6	"	SIMULATOR	MEP	MEP			TRIPLE ENGINE FAILURE LOSS OF ALL HYDRAULICS, EMERGENCY PROCEDURES, LOW LOW PRESSURE, HIGH PANICKED, CABIN SUPERVISOR OF ALL EMERGENCIES	1/1	2	3	
6	"	"	MEP	MEP					2	6	
10	G-1159B	N409JE	TIST	TEB		1604	JE, SK, KELLY MCCARTHY, MARCIE [illegible], DEANA STEGAN-BIRKS		2	0	
15	"	"	TEB	TIST		1605	JE, GM, RYAN DIONNE, MARCIE [illegible], ANDREA		4	3	
15	"	"	TIST	PBI		1606	REFLECTION		3	6	
									2	6	
							Page Total	4/8	49	5	
							Amount Forward	6558 6206	8846	3	3 11 3
							Total to Date	6561 6214	8846	3	3 11 3

I certify that the statements made by me on this form are true.

Pilot's Signature [illegible]

HOUSE_OVERSIGHT_015666

EXHIBIT D

IN THE CIRCUIT COURT OF THE SEVENTEENTH JUDICIAL CIRCUIT IN AND FOR BROWARD COUNTY, FLORIDA

CASE NO.: CACE 15-000072

BRADLEY J. EDWARDS and PAUL G. CASSELL,

Plaintiffs,

vs.

ALAN M. DERSHOWITZ,

Defendant.

_____/

VIDEOTAPE CONTINUED DEPOSITION OF

ALAN M. DERSHOWITZ

VOLUME 3
Pages 334 through 461

Tuesday, January 12, 2016
9:46 a.m. - 11:59 a.m.

Tripp Scott
110 Southeast 6th Street
Fort Lauderdale, Florida

Stenographically Reported By:
Kimberly Fontalvo, RPR, CLR
Realtime Systems Administrator

HOUSE_OVERSIGHT_015668

1 **Virginia believes she has been hurt by you or Prince**
2 **Andrew, she should be suing for damages?**
3 MR. SCOTT: Objection, form.
4 A. I don't recall.
5 BY MR. EDWARDS:
6 **Q. Have you ever said, "I welcome that**
7 **lawsuit"?**
8 MR. SCOTT: Objection, form. You should
9 identify what you're publishing from.
10 MR. EDWARDS: I'm asking if he's ever made
11 the statement to anybody other than his
12 lawyers.
13 A. I know I said that I welcome any
14 opportunity to put Virginia Roberts under oath and
15 to have her cross examined to establish that
16 everything she's said about me is totally false,
17 which I'm confident we can do.
18 BY MR. EDWARDS:
19 **Q. After making that statement, were you**
20 **presented by Mr. Scarola, I believe, with a waiver**
21 **of the statute of limitations in order to oblige you**
22 **on filing that lawsuit?**
23 A. Mr. Scarola wrote me a nasty letter that I
24 didn't think it was appropriate to respond to. What
25 I did do is state under oath that she was lying and

HOUSE_OVERSIGHT_015669

1 state under oath that I did not have sex with her,
2 thereby opening myself up --
3 MR. EDWARDS: This again is nonresponsive
4 to the question.
5 SPECIAL MASTER POZZUOLI: Let me stop --
6 repeat the question so we can get an answer.
7 BY MR. EDWARDS:
8 **Q. The question is, were you sent a waiver of**
9 **the statute of limitations to sign so that Virginia**
10 **Roberts could bring that lawsuit? Were you?**
11 A. I don't believe that's right. I don't
12 believe that's right. I don't believe that I was
13 sent a -- something that would give her the
14 opportunity -- a waiver to file that lawsuit.
15 That's not my recollection. If you show it to me,
16 maybe my recollection will be refreshed.
17 I had talked about the statute of
18 limitations for criminal purpose was what I said,
19 that I would waive the statute of limitations for
20 criminal purposes. If a prosecutor were to
21 investigate this case and come to the conclusion
22 that there was probable cause that I had committed
23 any offense with Virginia Roberts, I would then
24 waive the statute of limitations.
25 **Q. Okay.**

HOUSE_OVERSIGHT_015670

Robin Solomon

In a career spanning three decades in academic medicine, Robin Solomon has combined patient care, clinical research, philanthropy and business development expertise to build strategic alliances, brand recognition and revenue. In evolving leadership roles at The Mount Sinai Medical Center, she has developed a reputation for her innovative programming, quick grasp of new situations and common sense approaches to challenging problems.

She is recognized for her comprehensive understanding of the healthcare sector, including operating models, the political and regulatory environment, shifting demographics, financial opportunities and economic trends. Her eighteen years as an ICU nurse informs the way she navigates patient care on a human level, collaborates with physicians and persuasively conveys the potential impact of philanthropic gifts to donors.

Board and Donor Relations, Medical Navigation. As Vice President, Trustee Services, Robin developed and led a high-touch, best in class Donor Relations program. The services include 24/7 medical direction, referrals and oversight to the Mount Sinai Board and donor community to optimize the patient experience. Robin established relationships and gained participation from prestigious corporate, financial, and legal firms including Goldman Sachs, Paul Weiss Rifkind, Schulte Roth, Donna Karan, Warner Music and Federated Department Stores. This program has generated hundreds of physician referrals and over $20 million in incremental revenue each year. As a patient advocate, Robin has participated in thousands of multi-disciplinary patient care teams from initial consults to final outcomes.

Philanthropy. Robin's trusted relationships with medical, business, civic, and community leaders enable her to secure funds needed to advance medical, academic and patient care initiatives. During her tenure, she raised over $29 million in donations from individuals, corporations and foundations. Robin conceived, co-chaired and ran "A Toast to Health" an annual wine benefit, which raised $17 million dollars over nine years, consistently attained over 85% event underwriting. She has directed philanthropic funds to capital projects including an upgrade of the emergency room, complete renovation of the Neonatal and Pediatric ICU's and state-of-the art modernization of a medical school lecture hall. Her efforts have also provided $2.8 million for scholarships to The Mount Sinai School of Medicine and supported programs including Visiting Doctors, Palliative Care Fellowships, and perinatal bereavement social work.

Global Health. Robin has planned and executed cogent responses to critical international medical needs. At the request of President Clinton's office, she arranged for physicians and medical supplies to be sent with first responders in the days following the 2010 earthquake in Haiti. She collaborated with military leaders, USAID, and Dr. Paul Farmer of Partners in Health to organize transport of fully supplied surgical teams and re-open the University Hospital in Port au Prince. In 2006, in close coordination with Liberian President Ellen Johnson Sirleaf and her ministers, Robin established a medical mission to Liberia. She obtained private funding to send physicians and support personnel to provide medical care and surgical interventions. The project has continued and led to administration of the first chemotherapy and pap screening clinic in Monrovia.

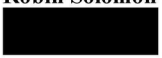
Clinical Research Leadership. As Assistant Dean for Clinical Trial Operations and Business Development, she designed and led the Office of Clinical Trials, key to advancing translational research. She launched marketing and outreach programs to convey Mount Sinai's research capabilities. These efforts attracted ongoing contracts from Novartis, Smith Kline Beecham, Amgen and Pfizer and other pharmaceutical and biotech companies. She facilitated over $18 million in grant funding, increased clinical trials by 40% and grew patient enrollment by over 320% annually.

Robin was Senior Research Coordinator on a CDC multicenter study measuring the effects of using safety devices for drawing blood, inserting IV's and giving injections. The manufacturers extended the study solely at The Mount Sinai Hospital. This research opened the multi-billion dollar market for safety devices. Earlier, Robin coordinated and performed clinical research at Cornell University Medical College's Surgical Metabolism Laboratory.

Patient Care. Robin's clinical expertise was developed over more than eighteen years as an ICU nurse at New York Hospital, Columbia-Presbyterian Hospital and The Mount Sinai Medical Center. The scope of her medical knowledge reflects years of hands-on patient care and thousands of decision-making conversations with physicians and families.

Robin holds a Master of Science in Exercise Physiology, *cum laude* from the University of Massachusetts and Bachelor of Science in Nursing, cum laude from the University of Florida.

Robin Solomon



EXECUTIVE PROFILE

In a career spanning three decades in academic medicine, Robin Solomon has combined patient care, clinical research, philanthropy and business development expertise to build strategic alliances, institutional recognition and revenue. In evolving leadership roles, she has developed a reputation for her clear and effective communication style, innovative programming, quick grasp of new situations and common sense approaches to difficult problems.

Robin is recognized for her comprehensive understanding of the healthcare sector, including operating models, the political and regulatory environment, shifting demographics, financial opportunities and economic trends. Her 18 years as an ICU nurse informs the way she navigates the patient experience on a human level, collaborates with physicians, and persuasively conveys philanthropic opportunities to donors.

PROFESSIONAL EXPERIENCE

The Mount Sinai Medical Center, New York, N.Y. (1993-2016)

Vice President Special Projects, Office of the President *(2015-present)*

- Receive and direct high-level medical and administrative inquiries from the Board and donor community. Manage transition of prior responsibilities to the Executive Services group.
- Secure philanthropic support, oversee medical procedures and personal care for several global health patients in collaboration with Dr. Randall Owen and his team.

Vice President, Trustee Services *(2005-2015)*
Director of Development *(2002-2005)*

Launched and led a Donor Relations program to provide high-touch, best in class 24/7 medical navigation and oversight for trustees, donors and patients referred by leadership and staff. Established and maintained philanthropic relationships with corporations, law firms and financial companies including Goldman Sachs, Paul Weiss Rifkind, Schulte Roth, Donna Karan, Warner Music and Federated Department Stores. Extended the Mount Sinai Medical Center brand to a broader patient base.

- Raised over $29 million in donations from individuals, corporations and foundations.
- Co-chaired and ran "A Toast to Health" an annual wine benefit. Raised over $17 million dollars over nine years. Consistently attained over 85% event underwriting.
- Directed philanthropic funds to capital projects including emergency room upgrade, complete renovation of the Neonatal and Pediatric ICU's and state-of-the art modernization of a medical school lecture hall.
- Provided $2.8 million for scholarships to The Mount Sinai School of Medicine, the single largest donation to date. Supported programs including, Visiting Doctors, Palliative Care Fellowships, perinatal bereavement social work and emergency medicine residency training.
- Engaged three new Trustees and four new members of the Mindich Child Health and Development Institute Advisory Board who collectively contributed over $10 million.
- Generated physician referrals resulting in hundreds of additional surgical admissions and over $20 million in incremental revenue each year.
- Managed refurbishing of ten family waiting areas. Obtained $1 million in pro bono services by notable decorators. Handled all logistics and ensured compliance with infection control regulations.

HOUSE_OVERSIGHT_015672

Global Health Project Leader (2002-2015)
Planned and executed medical missions with global health experts:

Haiti Earthquake Response. At the request of President Clinton's office, arranged for physicians and medical supplies to be sent with first responders in the days following the earthquake in 2010. Collaborated with Dr. Paul Farmer of Partners in Health to re-open the University Hospital in Port au Prince.

- Organized transport of 5 full surgical teams and all required equipment. Over ten days, the teams treated 400 patients and performed 50 surgeries.
- Personally requested emergency use of corporate jet from CEO of Honeywell and delivered needed supplies during the early days of the mission.
- Communicated with military leaders to obtain necessary landing slots, protection from the 82nd Airborne, and tents from USAID to house patients and orphans.
- Negotiated resupply without cost of all supplies and medications provided by Mount Sinai.

Liberia Medical Missions. Patients received the first chemotherapy in Liberia and a pap screening clinic was opened in Monrovia in 2014 in response to the large number of advanced stage cancers diagnosed during annual missions. Program continued through 2014, to resume post-Ebola.

- Coordinated directly with Liberian President Ellen Johnson Sirleaf and her ministers in 2007, 2008.
- Obtained private funding to send 30 physicians, medical students and support personnel to provide medical care and surgical intervention.

Director of Strategic Initiatives (2001-2002)
Planned and facilitated an 18-month program of events to commemorate the institution's 150th anniversary, reporting to the Executive Vice President and Board of Trustees. Highlights included: opening ceremony with Mayor Bloomberg, archival retrospective at the Museum of the City of New York, Community Health Day with free medical services and screenings to over 1500 attendees, and an Academic Symposium.

- Secured $800,000 in corporate sponsorship across the portfolio of events.
- Oversaw contract and filming of documentary video on the history of Mount Sinai Hospital.

Assistant Dean for Clinical Trial Operations and Business Development (1998-2001)
Designed and managed the Office of Clinical Trials, a key organizational and operational component advancing clinical trials and translational research. Developed strategic and operational plans. Prepared grant applications and negotiated contracts for extramural funding involving federal, industry and non-profit foundations. Attended and organized research conferences. Strengthened overall regulatory compliance and fiscal compliance with third party payors.

- Launched marketing and outreach program to convey Mount Sinai's research capabilities.
- Attracted ongoing contracts and right of first refusal in phase III clinical trials (with appropriate patient populations) from Novartis, Smith Kline Beecham, Amgen and Pfizer and other pharmaceutical and biotech companies.
- Grew research revenue by increasing clinical trials by 40% and patient enrollment by over 320% annually, from inception.
- Secured $12 million in NIH funding and ran program on a $1.5 million budget resulting in a profitable operation beginning in year one.
- Facilitated contracts between faculty and pharmaceutical and biotech companies resulting in $500,000 in funding for investigator initiated research projects.
- Awarded $5 million grant from the American Heart Association after reworking a previously submitted and unfunded NIH grant proposal.
- Attained membership in the Smith Kline Beecham Development Partners Program and $500,000 annually in upfront quarterly payments to ensure consistency among clinical research coordinators.

HOUSE_OVERSIGHT_015673

- Created a career track for Clinical Research Coordinators including ACRP certification opportunities and a centralized pool of research coordinators to promote steady workflow.
- Commissioned an audit of 10% of all active human subject trials for compliance to good clinical practice (GCP). Collaborated with Institutional Review Board (IRB) Chair when remediation was necessary. Sat on the IRB.
- Invited by Dr. Barry Coller, Chairman of Medicine to join the Patient Oriented Research Committee.

Senior Research Coordinator, Division of Infectious Diseases (1993-1997)
Collaborated with the Hospital Epidemiologist as Senior Research Coordinator on a CDC multicenter study to measure the effects of using safety devices to draw blood, start IV's and give injections to determine if they decreased needle sticks in healthcare workers. The device companies (Johnson and Johnson, Becton Dickenson and Vacupro) extended the study solely at The Mount Sinai Hospital. This research opened the multi-billion dollar market for safety devices.

- Hired study personnel. Arranged with Procurement to cancel contracts to remove non-study devices from the institution.
- Inserviced 3000 nurses and physicians on the use of the study devices.
- Audited sterilized used "sharps boxes" to assess implementation rates of the study devices.
- Included as a co-author of an article in *Morbidity and Mortality Weekly Report.*

Cornell University Medical College, New York, N.Y. (1986-1993)

Department of Child Development, Research Nurse Coordinator
Coordinated a National Institute of Mental Health funded pediatric study. Recruited subjects, developed tools to achieve stated research goals, implemented research protocols, analyzed data and prepared reports.

Department of Surgery Research Nurse Specialist
Established initial infrastructure and managed a multi-site surgical metabolism laboratory consisting of 4 full-time surgical fellows with an annual budget of $800,000. The study data and collaboration with Dr. Anthony Cerami's laboratory at Rockefeller University supported Dr. Kevin Tracy's seminal work on tumor necrosis factor (TNF). Implemented federally funded research protocols. Procured and managed supplies. Recruited control subjects and hospitalized inpatient subjects and obtained informed consent.

- Assisted physician researchers with all clinical and laboratory aspects of the study including processing, cataloging, transporting and storing specimens.
- Carried out study protocols for ICU inpatient and outpatient human subjects.
- Prepared submissions for IRB approval to assure patient safety and regulatory compliance.

Critical Care Registered Nurse, New York, N.Y. (1988-1997)

Neonatal ICU nurse at Mount Sinai, New York Hospital, Lenox Hill Hospital, Columbia-Presbyterian Hospital, contracted through a hospital staffing agency.

New York Hospital, New York, N.Y. (1979-1988)

Registered Nurse, Neonatal ICU. Delivered care to critically ill infants. Supervised ancillary personnel, assigned nursing staff, maintained detailed written records and electronic medical records for all patients.

EDUCATION

University of Massachusetts, Amherst, Massachusetts. M.S. Exercise Physiology, *Cum Laude,* 1987.

University of Florida, Gainesville, Florida. B.S. Nursing, *Cum Laude*, 1979.

HOUSE_OVERSIGHT_015674

How Alan Turing invented the computer, helped win World War II and left us with one of the greatest puzzles of our time: are humans simply computers or are we more than that? Many scientists think we have a tenuous hold on the title, "most intelligent being on the planet". They think it's just a matter of time before computers become smarter than us, and then what? This book charts a journey through the science of information, from the origins of language and logic, to the frontiers of modern physics. From Lewis Carroll's logic puzzles, through Alan Turing and his work on Enigma and the imitation game, to John Bell's inequality, and finally the Conway-Kochen 'Free Will' Theorem. How do the laws of physics give us our creativity, our rich experience of communication and, especially, our free will?

Can a computer win the imitation game and pass the Turing Test?
Why do creative people make better mates than rich people?
Why are humans bad at mathematics, yet so creative?
Could an infinite number of monkeys write Hamlet?
Is our brain a quantum computer?
Is free will an illusion?

James Tagg is an inventor and entrepreneur. A pioneer of touchscreen technology, he has founded several companies, including Truphone, the world's first global mobile network. He holds numerous patents, filed in over a hundred countries. He studied Physics and Computer Science at Manchester University, Design at Lancaster University and Engineering at Cambridge University. He lives with his family on a farm in Kent, England.
www.jamestagg.com

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"I can't tell you when the last time was that I had this much fun reading and using my brain. From the very beginning, James Tagg had me hooked with the premise; the question of whether or not humans are the most intelligent beings on the planet...."

Janet, Netgalley

"This is a fantastic book. It seams together cutting edge neuroscience, psychology, thought experiments, artificial intelligence/machine learning, mathematics and even some history!..."

PFJ H., Amazon

"Hard work to read, but makes you think about the nature of human intelligence and AI..."

Brian Clegg, Popular Science

"This is a fat book that covers a huge amount of ground. James' topic is primarily the brain and how we think, but there is a running theme contrasting the human brain with computers. His thesis is that computers can never think like humans (for example, that they can never be truly creative) and he explores many fields from philosophy and logic to mathematics in pursuit of this proof...."

R. Hanbury, Amazon

If you have enjoyed reading this book please leave a review and if you would like to hear more, or come to one of my talks, please join the mailing list at: www.jamestagg.com/updates.

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Are the Androids Dreaming Yet?

Amazing Brain.
Human
Communication,
Creativity &
Free Will.

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JAMES TAGG

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To my family,
who have patiently listened to my interminable
ramblings about 'Elephantine' Equations.

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PREFACE

ACPMM, Wolfson College, Cambridge

"A man may have twenty years of experience, or one year of experience twenty times."

Mike Sharman

"Rules are for the obedience of fools and the guidance of wise men."

Douglas Bader

I am an inventor. I've always been an inventor. Ever since childhood I've tinkered with electronics and computers, taking things apart and putting them back together. There is no academic course for inventing, so I had to choose my own path through school and University. I studied design, physics and mathematics at secondary school, and engineering and management at University. Part of that time was spent in the Engineering Department of Cambridge University on a particularly special course.

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Mathematical Bridge, Cambridge

Every autumn about thirty graduate students arrive at the Engineering Department in Cambridge to join the Advanced Course in Design, Manufacturing and Management. They expect to spend the year walking among the city's hallowed spires, attending lectures, bumping into Stephen Hawking and punting on the River Cam.

Instead, they get quite a shock!

In 1989, I joined the course. There were twenty-six engineers, a psychologist and a physicist – me. There was no prescribed syllabus; instead the course used learning-by-experience and lectures from the experts in a given field. To study advertising, you might visit a top London agency, for shipbuilding a shipyard on the Clyde. If you were unlucky enough to find these two lectures scheduled for the same week, you had to travel the length of Britain. The course runs a half dozen minibuses to solve this transport problem. Every four weeks we would undertake a project in a different company. I remember designing pit props for coal mines and imaging software for a weaving company. At the end of each project we presented our findings to each other and, with eight projects and thirty students, this made for a great many presentations. To keep the process manageable, the course put great store in teaching us the art of communication.

These days I design large complex systems, and clear communication is extremely important. My ideas are often turned into working products and, if those products have flaws, a post-mortem usually shows the cause

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was a breakdown in communication. Of course, this may be a purely personal failing, but when I talk to people in other companies they report the same problem. It seems we all find communication difficult.

have wondered for many years why it is called the 'art of communication'. Surely it's a science, governed by bits, bytes and bandwidth. That might be true of the symbols in an email – they are clearly encoded symbolically – but is the understanding in our brains simply encoded by symbols? What is the physics that underlies human understanding?

Each summer I go on holiday to escape engineering for a couple of weeks. While away I indulge my passion for reading books by the likes of Douglas Hofstadter, David Deutsch and Stephen Hawking. One book that struck me years ago was Roger Penrose's *The Emperor's New Mind*. In it, he tackles the question of what happens in the human brain when we understand something. He extends an idea put forward by J.R. Lucas of Oxford University that minds must be more powerful than computers because they do something computers cannot: namely to step beyond mere rules and see truth. Colloquially we call this 'common sense' or 'stepping outside the box'.

The Lucas argument uses the theories of Gödel and Turing to show computer algorithms have limitations. Some things are simply not computable. Computers can do many useful things, but they cannot discover new mathematical theorems, such as a proof of Fermat's Last Theorem. In 1996, Andrew Wiles succeeded in finding a solution to this problem. This presents a paradox, solved only if we conclude Andrew Wiles is not a computer. Indeed, since most mathematicians discover at least one theorem during their lives, we must conclude no mathematician is a computer! This is controversial. Most philosophers tend to the view put forward by Daniel Dennett that the Universe is an entirely determined place and any personal sense of free will and creativity is an illusion. In Dennett's worldview, Andrew Wiles is a special purpose machine that was always destined to solve Fermat's Last Theorem. I believe this model is flawed. It is my aim in this book to show you why. Indeed I am going to go further and argue all human creativity is non-computational; art, communication, understanding – all are based on non-algorithmic principles.

If you consider creative thinking deeply enough you're inevitably drawn into the question of whether we have free will. When I get to work each morning, the first thing I do – after a cup of coffee, obviously – is choose which creative task to tackle first. I feel this choice is freely made, but the determined determinists assure me I am wrong and my

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decision was already made. As Daniel Dennett says, "You have no free will. Get over it!" They say I am effectively an avatar in some giant cosmic computer game, going about my business in an entirely predefined way. I do not agree! If they are right all the coincidences and chance actions of my life were fixed at the time of the Big Bang. I feel this must be wrong, but finding a chink in the determinist armor is hard work; the laws of physics as we know them today are almost exclusively deterministic. This book lays out the options – the chinks – that would allow free will to enter our Universe.

To understand human thinking we would really like to look inside a working human brain. We can't do this yet. All we can do is observe minds at work when they communicate with one another. If our minds think non-computationally – as I believe – we should be able to see them struggle when they have to translate thoughts into symbolic form. The more symbolic, the harder it will be. This is indeed what we observe: face-to-face communication is easy, while formal written modes are much harder. We will explore the difference between human and computer communication as our first step in locating the weakness in the armor of determinism.

What do I Believe?

As a scientist, I ought not to have beliefs. I should have theories and working assumptions. But, as a human being, I must admit believing certain things are true. Science does not forbid beliefs. It just requires you to be prepared to have one overturned if a better one comes along. Richard Feynman summed this up in a lecture he delivered at Cal Tech: "If you want to discover a theorem," he said, "first, you guess, then you work out some effect predicted by the theorem. Finally, you see if the effect happens in the real world. If it does, you have a good theory. If the effect happens a little differently, you will need to look for a better theory." Here are some of my overturn-able beliefs.

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Beliefs

- We have true free will. We consciously decide our actions and these decisions are in no way predetermined. We shape the future. Allowing for free will is, therefore, a boundary condition for any theory of our Universe.

- The world is an amazing place, but understandable. We can understand the Universe through the application of thought and reason.

- There is only one Universe and it appears to make sense.

- Humans think creatively, computers do not.

- The process of understanding and communication is complex, much more complex than the digital theorems of Claude Shannon and Harry Nyquist.

- Understanding is hard.

- The communication of understanding is even harder.

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"It is no good getting furious if you get stuck. What I do is keep thinking about the problem but work on something else. Sometimes it is years before I see the way forward. In the case of information loss and black holes, it was 29 years."

Stephen Hawking

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Introduction

EXPERIMENTS, MULTIMEDIA AND PUZZLES

Throughout this book you will come across experiments to try, multimedia references to track down, and puzzles to solve. You can get additional information at www.jamestagg.com/understanding.

If you undertake an experiment I would appreciate your leaving a note of your results on the website and making useful comments on the blog.

Most of the experiments and puzzles are quick and simple. The puzzles I have set often benefit from creative thinking. I have made finding the answers to these problems a little hard, so you are not tempted to cheat. I want you to try to solve the problems and 'feel' your brain working.

This book argues that intuitive thought solves problems in a different way to analytical thought. The process takes time and often benefits from putting a problem to one side while you use your mind to process foreground tasks. I hope you read this book at a time when the website is not available – or at least don't peek. Give your intuitive thought processes time to work.

Graham Wallas described the process of creative thinking in 1926 and I think it is still one of the best models we have:

> First you must prepare and become fully acquainted with the problem. It might seem impossible but don't despair, just commit to it. Next, you should leave the problem to stew – incubation, he called it. After a while, you will feel a solution is at hand. You don't quite have it yet but you are

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sure you will. This is intimation. Finally, some inspiration or insight will pop into your head – this is the Eureka moment. Now you have a solution but intuitive thinking is far from infallible. You will need to check the solution and may find your answer wrong the first few times. Persevere; you will get there in the end.

As a warm-up exercise, let me give you a simple childhood riddle to solve.

A man lives on the twentieth floor of a skyscraper with an old elevator. Each morning he gets into the elevator and goes down to the ground floor, but each evening he gets into the elevator, travels up to the tenth floor, gets out, and walks the rest of the way. Why?

ANSWER IN YOUR OWN TIME

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Chapter 1

MIND OVER COMPUTER

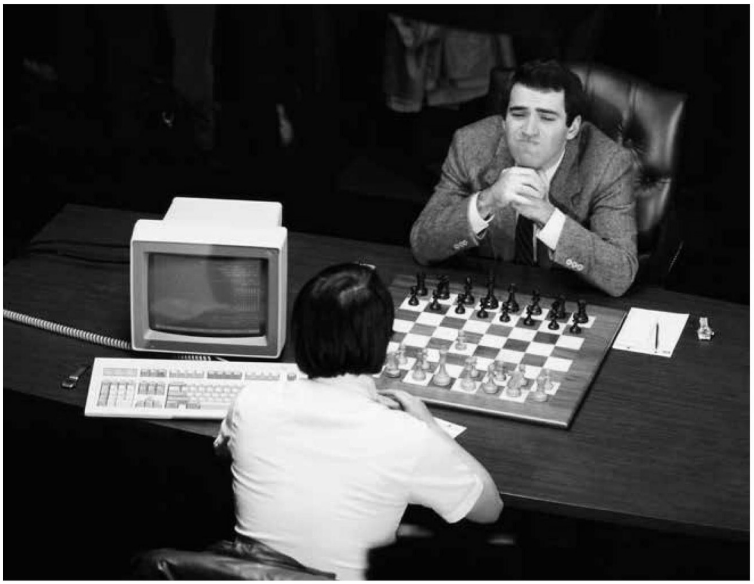
Computer versus Human

"I visualize a time when we will be to robots what dogs are to humans, and I'm rooting for the machines."

Claude Shannon

"The question of whether computers can think is just like the question of whether submarines can swim."

Edgar Dijkstra



Kasparov versus Deep Blue

"The Three Laws of Robotics:

1. *A robot may not injure a human being or, through inaction, allow a human being to come to harm;*
2. *A robot must obey the orders given it by humanbeings except where such orders would conflict with the First Law;*
3. *A robot must protect its own existence as long as such protection does not conflict with the First or Second Law. The Zeroth Law: A robot may not harm humanity, or, by inaction, allow humanity to come to harm."*

Isaac Asimov, *I, Robot*

Deep Blue

It is 1997 and we are on the 39th story of the Equitable Center in New York, watching a chess match. It's no ordinary match. Two men sit opposite each other. One, a neatly suited figure, stares intently at the board. You can almost see the heat rising from his head as he processes the possibilities before him. The other, sits implacably calm and, before each turn, looks to a screen at the side of the board, reads the instruction, and makes his move.

This is the famous match between Garry Kasparov and IBM's Deep Blue. Kasparov, a child prodigy, became world chess champion at the age of fifteen and, to this day, holds the record for the highest chess ranking ever achieved. Some consider him one of the most intelligent people on the planet. His opponent, Deep Blue, is a massively parallel chess-playing computer built by IBM's Watson Research Laboratory. The machine itself sits a few blocks north of the tournament in an air-conditioned room, and relays the moves over a phone line to Joe Hoane, the IBM researcher who moves the pieces.

Six months earlier, in Philadelphia, Kasparov won against Deep Blue. This is the rematch and has generated a worldwide media frenzy. Tickets to the event are sold out and most news organizations give a blow-by-blow report each day. On the eighth day of the tournament Kasparov and Deep Blue are level pegging. Kasparov is playing an opening he knows well. It's one designed to be hard for computers to play and has been tested extensively against Fritz, a chess computer Grand Masters use for practice. But Deep Blue doesn't seem fazed. Kasparov is visibly tired. On the 16th move he makes a dreadful blunder and sinks into despair. An hour later, after some moments of quiet contemplation, he tips over his

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king, gets up, and leaves the room. Kasparov has resigned, Deep Blue has beaten him 3½ to 2½ points and is now the most powerful chess player on the planet.

Later, when interviewed about his experience, Kasparov thought Deep Blue must have been assisted by humans during the games because the program appeared to play intuitively. The rules of the tournament allowed humans to work on the program between matches, but not during actual play. The argument has never been settled, and Deep Blue was long ago dismantled. These days chess players avoid big public matches against computers, arguing it is really a different sort of game. A computer's ability to crunch mathematically through all the many possibilities means a chess player must play without error against a machine, but can play a more interesting and fluid match against a fellow human.

Chess is computer-friendly because it is a finite problem. You always win, lose or draw. The game can't go on forever because any position that repeats itself more than three times is declared a draw, and if a player makes 50 moves without moving a pawn or taking a piece, the game is also declared a draw. In a typical game, each player makes 40 moves, and on each turn you can choose from 30 possible moves. Although this equates to a huge number of options, it is still a finite number.

It is possible, therefore, to create a perfect chess-playing machine. Such a machine would project any position it encountered through every permutation to the endgame. But, although chess is solvable using brute force this might not be practical in our Universe. The storage required to hold all the possible positions being analyzed would be vast – needing most of the atoms in the Universe. You would need to pack this information into a small enough space to allow fast retrieval in order to play the first 40 moves in two hours. This would require storing all the information within a sphere no larger than three light minutes. Putting that much data in such a small space would exceed the Hawking Bekenstein bound – a limit on the information carrying capacity of space-time put forward by Stephen Hawking and Jacob Bekenstein – causing the region of space-time to collapse to a black hole! Despite these minor technical problems, an ingenious algorithm could be made that was unbeatable: chess is essentially computable.

The term algorithm will often arise in the book, so it is worth giving a little history. The word comes from the name of an 8th Century Persian mathematician, Al-Khwarizmi, and means a step-by-step procedure. We use one whenever we do long division or look up a phone number on

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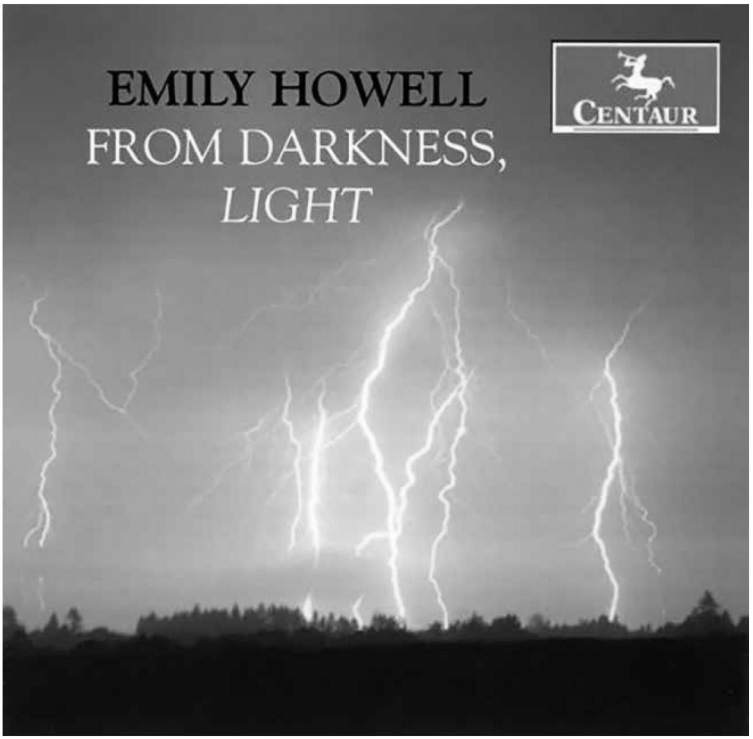

The Music of Emily Howell

our mobile phone. It is any mechanical procedure you perform without thinking about it. Computers are always executing an algorithm; that's what they do.

Fast forward to 2010 and Centaur Records releases a new classical music CD featuring the piano music of Emily Howell. Critics are enthusiastic about the new talent. She has composed music in a broad range of classical and contemporary styles. You can find some examples on my website.

But, it transpires, Emily is a computer, the brainchild of David Cope from the University of Santa Cruz. On hearing this news critics revise their opinion of the compositions – "repetitive and formulaic," "not real music," "pastiche". Listen again to the music and see whether you have changed your opinion. Whatever you think, Emily has made a good attempt at composing in the style of several great composers: J.S. Bach and Franz Liszt, as well as modern ones such as Stockhausen and

Philip Glass. The compositions would get a reasonable technical score in an exam, better than many of my attempts, but are these compositions truly art?

There's no question computers are gaining ground on us in certain mathematically oriented tasks – playing chess, musical composition, and various modeling tasks. But attempts to have them work with words and ideas have generally produced dismal results. Until now.

In 2008, IBM unveiled Watson: a computer capable of answering general knowledge questions. Watson has an enormous database of human knowledge: the Encyclopedia Britannica, a billion web pages, the entire text of Wikipedia and millions of books. It uses artificial intelligence to trawl through this vast reservoir of knowledge and answer questions using a statistical approach. In 2011, Watson featured as a contestant on Jeopardy, the American quiz show, where it beat the two record-holding contestants – the one with the highest number of wins and the one with most consecutive wins. Let me give you a few sample questions and see how you fare.

Question 1. It can mean to develop gradually in the mind or to carry during pregnancy.

Question 2. William Wilkinson's "An Account of the Principalities of Wallachia and Moldavia" inspired this author's most famous Novel.

Question 3. Its largest airport is named for a World War II hero; its second largest, for a World War II battle.

Watson answered questions one and two correctly but failed on question three. You can probably see the final question is posed in poorly structured English and this threw off Watson's comprehension algorithm.

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IBM's Watson Plays Jeopardy

Ignoring the odd hiccup, Watson is much better at Jeopardy than a human. Should humans be worried? First chess, then music, now general knowledge, will all human endeavors succumb to a computer? What will be our purpose on the planet if this happens?

Steve Wozniak

"Machines will run the world,
humans will become idle pets."

Steve Wozniak

Man v Machine

Are humans advanced computers with a temporary hold on the title, 'most intelligent being on the planet,' or are we fundamentally different?

We are extraordinarily creative, but we can't add up as well as a cheap pocket calculator. We have poor memories, but we can use common sense to solve problems we have never seen before. Our communication skills are woefully imprecise, but we can tell jokes that send our fellow humans into paroxysms of laughter. We might conclude humans are not computers, but the scientific consensus is that brains are 'wet computers'. I don't agree with this and I'm going to set out the argument to show why man is not a computing machine.

There is an urban legend we think with only 10% of our brains. This is not true. Science has mapped the vast majority of the human brain using two methods. The first, an amazing set of noninvasive imaging techniques, allows us to 'see' the brain as it thinks. The second is more macabre: with seven billion humans on the planet, enough accidents occur through sports injuries, car crashes and surgical mistakes to provide a large enough sample to conduct research. Questioning patients with brain-damage allows us to work out what the injured part did before the accident.

One famous patient had an accident where the blade of a toy sword went up his nose and damaged a small part of his amygdala and hippocampus, the area of the brain responsible for storing memory. This rendered the man unable to lay down permanent memories after the accident. Events before the accident remained clear but he could not memorize new information. You could tell a joke and he would find it

Turning Images to Music

funny and laugh uproariously. A few minutes later, you could tell the same joke and he would find it just as funny as the first time. For him, every time was the first time, because he had lost the ability to record long-term memories. The syndrome is wonderfully depicted in the film *50 First Dates* starring Adam Sandler and Drew Barrymore. Another patient with specific stroke damage was unable to recall the names of fruits but, oddly, could still name vegetables. Interestingly tomatoes presented a particular problem. He had probably never known how to catalogue them so they were partially remembered in both areas.

There are many such medical cases. In Oliver Sachs' *The Man who Mistook his Wife for a Hat*, the author relates the tale of a man with visual agnosia who could not reliably name familiar objects, including his own wife! He had a perfectly loving relationship with her but simply could not name her from a picture. Sachs, Professor of Neurology at New York University School of Medicine, provides many such fascinating stories, along with their medical backgrounds.

The fruit and vegetable case suggests our brains are organized like a filing cabinet. When we damage a part of the brain, it's like losing a drawer: All the information stored in that drawer is lost. Quite a few experiments contradict this model and indicate many tasks are distributed around the brain. The curious case of blindsight is one such example. People with a damaged visual cortex can often recognize objects despite reporting they have no sensation of vision. Show them a shape and they will report they can see nothing. Ask them to name the shape and they might even get a little irritated by the question; they are blind after all. But, ask them to guess the shape and they will get it right every time. Seeing is more

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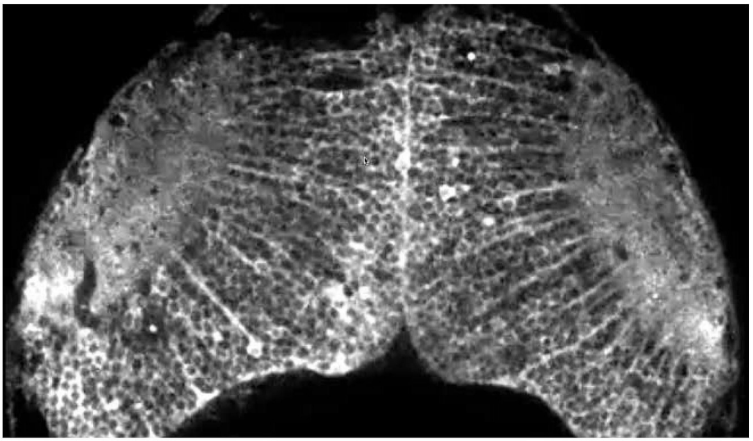

Brain Image of Fish Hunting Prey

widely distributed in the brain than was first thought. Conscious seeing is based in the visual cortex, but there are older pathways still active in the brain that facilitate this unconscious seeing.

The brain is very plastic. Lose your sight through damage to the eye or optic nerve, and the brain can repurpose the visual cortex to other uses such as processing sound or touch. Daniel Kish has developed this to such a high level that he can ride a bicycle despite being blind. He clicks his tongue against the roof of his mouth and uses echolocation to form an auditory model of the world around him. Using a similar approach, Amir Amedi from the Hebrew University of Jerusalem has built an audio imager that turns pictures of the world into musical sound patterns. CAT scans of people using this system show they use the visual cortex to convert these sound images into models of the world in similar parts of the brain to a sighted person.

We now know roughly *what* each part of the brain does, but we have no idea *how* it does it. The scale of an individual thought is too small to see in a brain scan. All we can do is observe large-scale electrical activity associated with those thoughts. A video, from a group at Tokyo University, shows an example of electrical activity filmed in real time as a fish hunts for its prey. Fish have transparent bodies and thin skulls facilitating this sort of imaging. Humans are much harder subjects to work with!

The most popular theory to explain how brains work is as some form of computer. Computers are easy to study because we manufacture them. They tend to crash quite frequently – usually at the most inconvenient

moments – so we have packed them with diagnostic monitoring systems. These systems allow us to watch a computer think and, since they think symbolically, we can easily read their minds.

Unfortunately computers don't display many human-like thoughts. They don't laugh and cry, they don't report consciousness and they don't appear to exercise free will or display creative impulses. This is frustrating because these are the thoughts we would most like to study. It might be that computers are not yet powerful enough, and in another few years they will be giving Mozart a run for his money. But there may also be a fundamental difference which renders them incapable of this sort of thinking. This is the crux of the modern scientific debate: do humans think differently?

Computer Brains

On the face of it, humans and computers *behave* very differently. Our memories are poor, but we understand things. We are creative, but bad at mathematics. We learn by example, computers are programmed. We are emotional, impulsive and appear to have free will. Computers are ordered, predictable, but lack common sense. Both humans and computers appear to be physical, discrete systems. We both take inputs, generate outputs and are capable of solving similar problems. Indeed, each time we examine a problem solved by humans we usually find we can automate it. This is known as 'knowledge engineering' and there are many examples; from aerospace to finance, and architecture to medicine.

An example of where computers excel is in medical diagnosis. ISABEL is a clinical diagnosis program designed to help ER doctors quickly diagnose critical patients. It was created by the parents of Isabel Maude, a little girl who presented with multiple symptoms to an ER unit. Doctors were initially confused by the symptoms and misdiagnosed her condition. She was later diagnosed with meningitis. Isabel suffered multiple organ failure but survived. Her parents realized there was something wrong with the ER triage process. They got together with some computer scientists and built the expert system 'ISABEL'. When ER doctors are presented with symptoms, they must mentally scan a vast array of literature to rule in and out possible diagnoses. The problem-solving process is not linear; if you've ever watched the TV series *House* it gives a great dramatization of the process. Certain symptoms might suggest a diagnosis but are not conclusive, and there are many paths to explore. Programmers have taken the heuristic rules from many doctors and codified them into software. ISABEL allows a doctor to input a set

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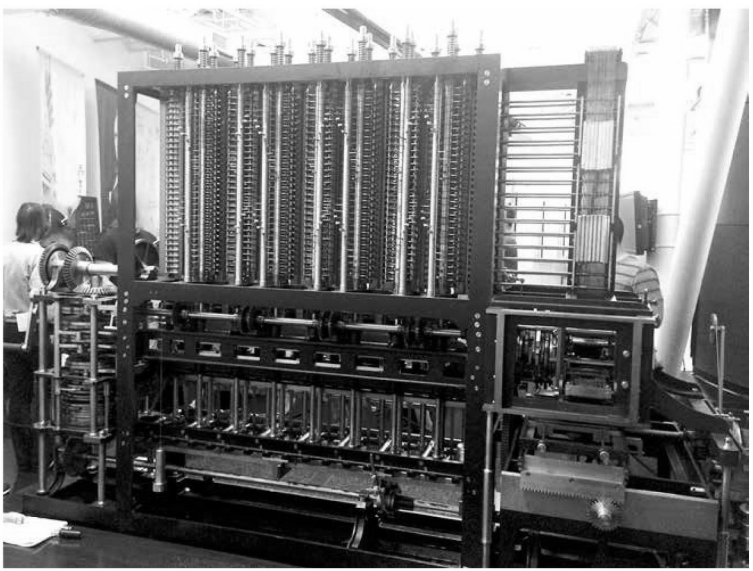
of symptoms and it will spit out a range of possible alternative diagnoses with probability weightings and suggested further tests. Similar systems are widely deployed in other fields, to build racing cars, design dams and fight crime. Even the game consoles in our living rooms implement artificial intelligence to make the aliens more believable and our hearts pump faster.

Origin of Computers

Alan Turing effectively invented the modern day computer in a paper he submitted to the London Mathematical Society in the summer of 1936. He was not the first person to come up with the idea – that honor probably goes to Charles Babbage – but he was the first to fully understand its power. When we talk about computers today we mean machines, but it is worth noting computers in Turing's time were more often humans using pencil and paper. The mechanical computers before Turing were elementary at best.

Rudimentary calculating machines were developed in Greece, Persia and China as far back as the Ming Dynasty. An astrolabe recovered from a ship wreck off the Greek Island of Antikythera had cogs and gears and could accurately predict the motions of the sun and planets. Many



Babbage's Difference Engine No. 2, Computer History Museum, CA

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of these skills were lost in the Dark Ages but, once the Renaissance was underway in the 16th and 17th centuries, complex mechanical clocks were devised that were capable of predicting the motions of the planets to a high degree of precision. Mechanical, hand-cranked calculators appeared in the mid-18th century, and in 1886 Charles Babbage conceived the first programmable computing machine, The Analytical Engine. It was designed to read programs from cards, and used cogs and wheels to perform the calculations. His first machine – The Difference Engine – was designed to help the Admiralty calculate tide tables, but Babbage realized he could generalize it to compute almost any function. He ran out of money to complete any of his machines, but in the 20th century a dedicated band of enthusiasts built a working model of Difference Engine No.2. One copy sits in the London Science Museum and another in the Computer History Museum in California. These difference machines are not Turing complete and his Analytical Engine has never been built.

19th Century Calculators

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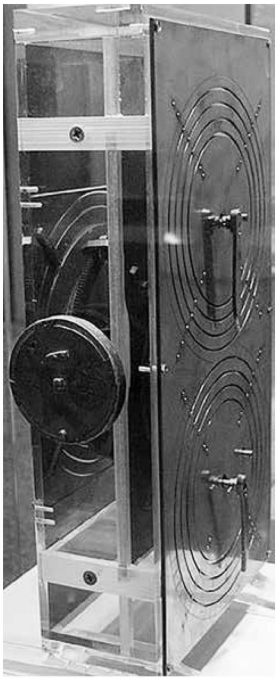
In 1935, Turing was made a Fellow of King's College, Cambridge, and became interested in whether mathematical proofs could be found automatically. He wanted to know whether solving a mathematical puzzle was simply a matter of working through all the possibilities in a methodical manner, or whether something more subtle was required. Although chess is a fantastically complex game, it is finite, a big enough, fast enough computer can play the perfect game. Is this the case with discovering knowledge? Could a big enough, fast enough computer calculate all the knowledge in the Universe? Is Douglas Adams' fabled computer Deep Thought a possibility, able to calculate the answer to the ultimate question of 'life, the Universe and everything', albeit with a more enlightening answer than 42?



Model of the Antikythera Mechanism

Turing boiled down the process of pencil and paper computation to a systematic program – a computer program. He proposed a thought experiment where he would run every possible program and see if such a procedure would yield the solution to every imaginable mathematical problem. He was able to show this would lead to a paradox and concluded the universal problem solver could not exist. His discovery is one of the most important of the 20th century – in the same league as relativity and quantum mechanics – and I will use it as my main tool in trying to explain the difference between brains and computers.

Although Turing's original paper was not intended as a blueprint for a practical device, he was one of those rare mathematicians who also liked to tinker with real world machines. The outbreak of the Second World War made the practical application of his work very important, and in Chapter 8 I will relate some of the code breaking stories that were to make him famous and caused Churchill to credit him with shortening the war by two years.

Calling Turing's work an 'invention' is probably the wrong term; 'discovery' might be more appropriate. Whatever you call it, people immediately equated human brains with computers. This is not new.

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Each time a new advance in technology is made, people use it to explain the working of the brain. The ancient Greeks thought the brain was a fire consuming oxygen. When Alexander Graham Bell invented the telephone, the nervous system resembled a maze of wires and the brain an exchange. Brains were obviously a sophisticated telephone system. This idea has some potentially frightening consequences, particularly in light of the speed at which computers are improving.

The most striking feature of computer technology is the rate of development. Cars travel faster than a person's legs will carry them, machines manufacture things faster than our hands are capable of working. If brains are computers, surely it is just a matter of time before they will think faster than humans. Turing predicted this would happen when computers reached the level of storing around 10 billion units of information. This happened some time in mid-2000. But today, in the year 2014, I can report that although my computer can beat me at chess, it still cannot fill out my expense report for me. So I am still ahead!

Maybe Turing just got the mathematics wrong. The human brain has about 10,000 times more neurons than our most powerful computers have logic gates. By this calculation, it's not a billion units of storage we need but, a trillion trillion units to put the computer on a par with a human brain. It's just a matter of time!

The worrying thing – especially for fans of the 'computers taking over the world' science fiction genre – is that computers are improving exponentially fast in line with Moore's Law, and the parity point is coming soon. Gordon Moore founded Intel with Andy Grove, and ran the engineering department there for more than 20 years. According to Moore's Law, the power of a computer doubles approximately every 18 months. The next significant event in the computer versus human competition is the gate count parity point – the moment when the number of logic gates and the number of neurons become equal. By my reckoning this will happen some time in 2053.

Don't despair. There may be a few dodges yet. The gate parity point assumes a logic gate and a neuron are equally powerful. However, some single cell organisms with only one neuron are capable of complex behaviors, such as hunting prey and avoiding obstacles. To perform these simple behaviors, a computer would need as many as 10,000 logic gates, about the complexity of my TV remote control. This gives us a bit more breathing space. The extra four orders of magnitude push the gate parity point out to around 2080, too late for me to see, but certainly within the bounds of some readers of this book.

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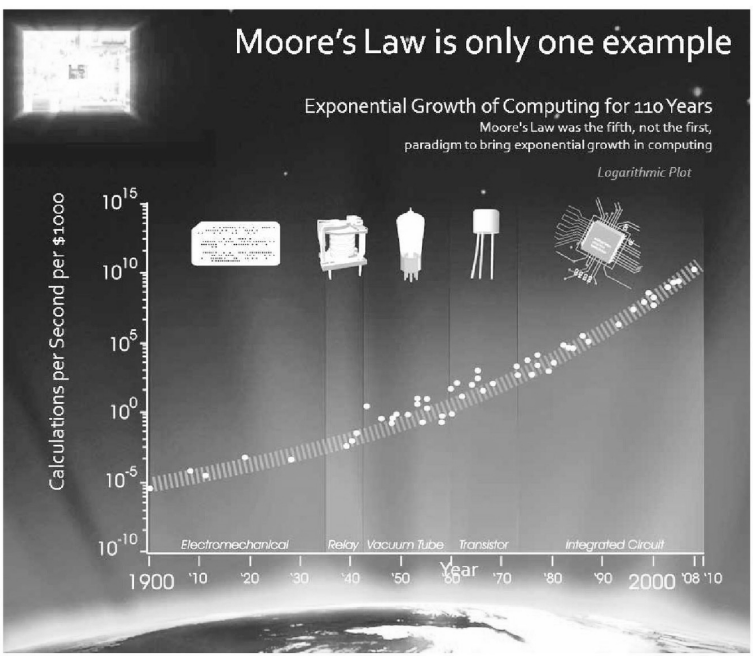
To give you some idea of how Moore's Law works, the graph shows growth in computing power over time; the y-axis is a logarithmic plot using engineering notation. Because the growth is exponential we rapidly end up with very large numbers. Scientists use a special notation to cope with these large and small numbers. In scientific notation a number is written out in a compact form. For example, three hundred can be written as 3.0×10^2. To expand it back to a regular number you move the decimal point in 3.0 two spots to the right, making the number 300.0. A similar technique is used for small numbers. To expand 3.0×10^{-2} move the decimal point 2 points to the left, giving 0.03. Why use scientific notation? Well, once the numbers get large they would no longer fit on a page! We can shorten the representation of numbers even further by dropping the '3.0 ×' part and just looking at the order of magnitude. The number 10^{80}, one with eighty zeroes after it, is the number of atoms in the Earth, and 10^{120} the number of particles in the known Universe. 10^{-43} meters is the 'plank number', believed to be the smallest dimension you can have, and 10^{100} is called a googol, named by Milton Sirotta, the



Moore's Law Extended by Ray Kurzweil

nephew of the famous American mathematician Edward Kasner, and subsequently the inspiration for the name 'Google', the Internet search engine.

Ray Kurzweil, the prolific inventor and futurologist, is fascinated by this exponential growth. Exponential curves grow slowly to start with but they pick up speed rapidly and, in the end, growth tends towards infinity. We are all painfully acquainted with one example of exponential growth: The common cold. Each infected cell in our body releases virus particles into the blood which infect further cells, leading to an exponential increase. This makes us feel rotten. Luckily our immune system can also respond exponentially, albeit somewhat delayed, so we survive. In the case of computer power there is no opposing immune system fighting back, so Kurzweil thinks computers will achieve almost limitless processing power; perhaps even within our lifetime. He thinks this will lead to some interesting consequences, for example, allowing people to live forever! Far-fetched? Follow his argument.

The two most important elements in keeping us alive are medical imaging, to see what is wrong; and genetic engineering, to fix those things. Both are improving in line with digital technology, doubling in power every 18 months. As computers get better at seeing into our bodies, and our ability to sequence and synthesize spare parts improves, we will reach a point where we can fix almost any problem. Kurzweil figures technology is improving and his body is decaying at just the right rate to mean by the time he needs heavy duty medical intervention it will be available. Barring a traffic accident or mad-axe-murderer, he should live forever. Even if his calculation is slightly off, the next generation will definitely have this option.

You might dismiss this as science fiction, but some amazing things are already happening. Recently a female patient in the USA suffering from bone cancer had her jaw replaced with a 3D printed component. Doctors were able to scan her head and take an image of the good side of her jaw, flip it right to left within the computer and repair any problems they saw. Then they sent the image to a 3D printer. The printer made a new jaw from tungsten powder, which was fused in a kiln. The final stage was to cover the metal part with an inert bone-like substance to give the human body a scaffolding on which to build real bone. They then performed the operation to remove her old jaw and replace it with the new one: result, brand new healthy jaw.

There are some practical limits to the power of computers on the horizon. Currently, the wires in a silicon chip are about twenty-two nanometers wide. That's around a thousandth of the width of a human

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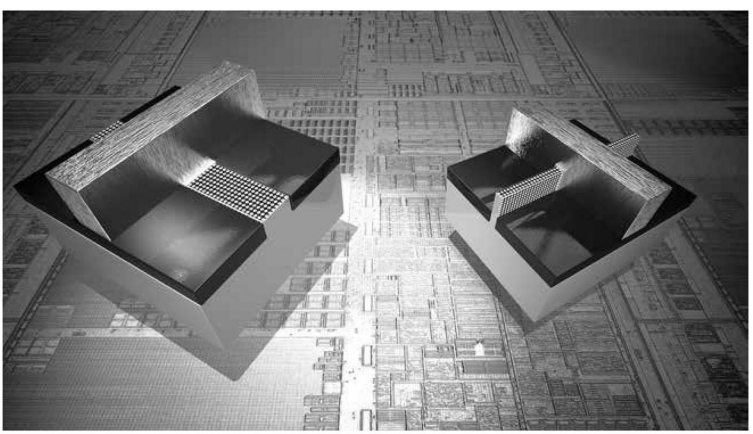
hair, or approximately two hundred atoms wide. To match the complexity of a brain we will need to pack an order of ten million more gates into a silicon chip. One way to achieve this is to simply shrink the wires, but when we get down to around ten atoms wide, quantum effects begin to dominate. Signals in today's chips involve tens of thousands of electrons. We normally think of these electrons as a group, but in these tiny circuits we need to consider the behavior of each individual electron. Problems arise as this behavior is subject to quantum uncertainty. With only ten electrons there is a finite probability that none of them will be where you were expecting them to be. This causes problems for digital logic. You can't put a '1' in a memory location and be sure when you come to read it you will get a '1' back. You have to factor in the possibility of error.

Quantum effects can be annoying – requiring us to devise all manner of error checking hardware – but they can also be helpful. Richard Feynman proposed using quantum bits, 'qubits', to perform computation. Quantum computers can calculate many times faster than a classical computer because a single bit can represent more than one piece of information. Enterprising entrepreneurs are making use of this effect to build the next generation of devices, and you can already buy a 512 qubit computer from a Canadian company called D-Wave.

The biggest problem with building more powerful conventional chips is their area is reaching the manufacturing limit for economic viability. Silicon wafers contain random spots of damage and, as a chip gets larger, the chance it will have one of these spots approaches certainty. One solution is to use the third dimension and print the logic



3D Chip, Intel

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gates so that they communicate in the vertical direction as well. Intel demonstrated the first three-dimensional chip in 2004, and these chips should begin to appear in our laptops by around 2020.

Taking a chip into the third dimension solves the economic problem but adding logic gates to a 3D chip presents a new problem – heat. Heat is generated in proportion to the volume of the chip but it can only be lost through the surface area. Result: the chip overheats. Large animals have the same problem which is why elephants have huge ears, filled with blood vessels, they can flap to cool themselves and really big mammals, such as whales, live in the ocean. The thermal problem is now the biggest problem in most computer designs. One data point suggests we could solve this problem, the human brain. We pack huge processing power into our skulls without overheating by using a variety of techniques, including folding the surface of the brain, running each neuron very slowly and maybe even using quantum mechanics. A very recent discovery is that brains could be using quantum effects to transmit signals. If true – and the research has only been recently published – it means we may use a form of high-temperature superconductivity to avoid overheating. More on this in Chapter 4.

Excluding exotic quantum effects, the main difference between computer and human brains is their processing architecture. Brains use slow, asynchronous logic to process information rather than the fast, synchronous type used in modern day computers. Logic gates in today's computers work all the time, even when there is nothing to do. For example, if I multiply 2 by 3 on my laptop the entire multiply circuit, designed to work on 20 digit numbers will still operate, and, even worse, it will operate on every tick of the master clock even if there is nothing to multiply. The brain, by contrast, works only as it needs; unused gates don't operate. This gives a massive reduction in unnecessary power consumption. We'd like to use this technique in modern computers but it is very difficult to implement. Tiny changes in timing cause completely different operation and this makes them hard to test. We accept this sort of problem in humans, calling it 'human error', but we count on computers to behave absolutely reliably, so full-blown asynchronous logic is not likely to appear anytime soon. Some of these ideas, however, have made their way into today's consumer devices. For example, the chips in the latest iPhone contain two CPUs: a small slow one operating when the phone is dormant in your pocket, and a large fast one that switches on when you need the power for a game or other high performance task.

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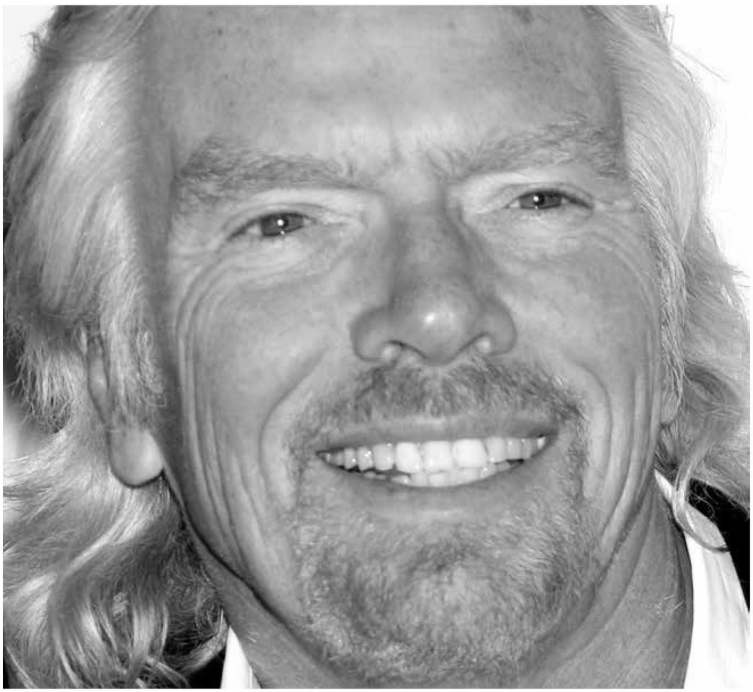
All things considered there doesn't appear to be a fundamental engineering problem that would prevent computer hardware reaching the complexity of the human brain. But, even with all this hardware, it's not clear we would have something intelligent.



Richard Branson

"I was dyslexic, I had no understanding of schoolwork whatsoever. I certainly would have failed IQ tests. And it was one of the reasons I left school when I was 15 years old. And if I – if I'm not interested in something, I don't grasp it."

Richard Branson

Intelligence

Although my computer appears to have a mischievous sense of humor – deleting files and crashing just before important presentations – it does not appear to enjoy listening to Bach, nor does it ever ask me to put it near the window to admire the view. I think this means it's not intelligent, but what is 'intelligence'?

Intelligence is hard to define; I usually conclude someone is intelligent if I have an interesting conversation with them. In the workplace we typically hire people based on interview, rather than practical tests. Could a computer hold a conversation with me and persuade me it is intelligent? Meet Eliza.

Invented by Joseph Weizenbaum of the Massachusetts Institute of Technology, and named after George Bernard Shaw's character in *Pygmalion*, Eliza runs an algorithm pretending to be a psychiatrist offering a sympathetic ear to anyone who cares to talk. Try her out at my website or read the sample dialogue below!

User: Men are all alike.
Eliza: In what way?
USER: Men are all alike.
ELIZA: In what way ?
USER: They're always bugging us about something or other.
ELIZA: Can you think of a specific example ?
USER: Well, my boyfriend made me come here.
ELIZA: Your boyfriend made you come here ?
USER: He says I'm depressed much of the time.
ELIZA: I am sorry to hear that you are depressed.
USER: It's true. I am unhappy.

ELIZA: Do you think coming here will help you not to be unhappy ?
USER: I need some help, that much seems certain.
ELIZA: What would it mean to you if you got some help ?
USER: Perhaps I could learn to get along with my mother.
ELIZA: Tell me more about your family.
USER: My mother takes care of me.
ELIZA: Who else in your family takes care of you ?
USER: My father.
ELIZA: Your father ?
USER: You are like my father in some ways.
ELIZA: What resemblence do you see ?
USER: You are not very aggressive but I think you don't want me to notice that.
ELIZA: What makes you think I am not very aggressive ?
USER: You don't argue with me.
ELIZA: Why do you think I don't argue with you ?
USER: You are afraid of me.
ELIZA: Does it please you to believe I am afraid of you ?
USER: My father is afraid of everybody.
ELIZA: What else comes to your mind when you think of your father ?
USER: Bullies.
ELIZA: Does that have anything to do with the fact that your boyfriend made you come here ?

If you think Eliza a bit odd, you are right. Perhaps you won't hire her just yet. The program looks for keywords in speech, and parrots them back at you interspersed with a few stock phrases. If you type a sentence containing the word "job", the computer will say, "Tell me more about your job." It's a simple program and runs to only three pages of text. It shows how good a job you can do with very few resources and how far we are away from a real human being. More complex programs with a larger repertoire have been built and can hold a plausible conversation. People are occasionally taken in by them and are quite shocked when told they have been conversing with a machine. If you're on your guard, they are easy to spot. So far, no one has built a computer capable of holding an extended human conversation and fooling a human into thinking it's a person. Incidentally, having a sympathetic listener is so important to human beings these programs are used in psychotherapy and can be as effective as drugs.

Turing proposed a test to tell whether a computer had truly achieved human intelligence called the imitation game. His argument is as follows:

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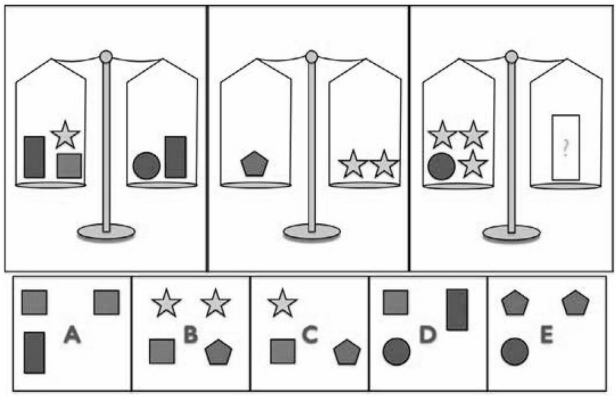

IQ Test

Humans are intelligent. (If you disagree with this premise then you're going to have a problem with this argument!) If you talk to a computer and cannot tell it from a human, it must also be intelligent: QED. The logic is sound but somehow feels wrong. It neatly, but irritatingly, sidesteps the whole problem of defining intelligence.

In 1912, William Stern devised a method for measuring intelligence in children. He named it 'IQ' from the German Intelligenz-Quotient. You may have taken one of these tests at school. The tests consist of a series of abstract reasoning problems that minimize cultural references. For example, you might be asked to look at a set of blocks with dots on them and identify which is the odd one out. Numerous versions of the test have been developed over the years, but nowadays we mostly use one of three standard tests, Wechsler being the most common.

Measuring intelligence is complicated. Culture and language play a big part. If we take a tribe of Amazonian Indians and ask them to list the presidents of the United States, they will fail. That does not mean they're stupid. Drop me into the Amazon Rainforest and I will probably starve to death; they, on the other hand, can live off the land as hunter-gatherers with only a few hours work per day. Who is more intelligent?

One problem with IQ is that individual candidate scores can differ wildly from test to test, sometimes by as much as 20 points. That's huge. At the high end of the scale it can be the difference between being classified as smart or as a genius; and, at the low end, between being average or mentally subnormal. These variations don't usually matter and most universities and colleges take IQ with a pinch of salt, preferring more specific tests such as SATs in America, the Baccalaureate in Europe or A levels in the UK. IQ can be very important; and is sometimes a matter of

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life or death. In Atkins v. Virginia, the US Supreme Court found a person with mental disability, defined as having an IQ of less than 80, cannot be executed.

IQ is not really a measurement, in the normal sense. Most measurements in life are absolute, for example, distance, weight, and time. I can prove my house is bigger than yours using a tape measure. We each ensure our measures are the same by calibrating them against a common reference. In the 1900s we could have walked down to the local town hall and checked our measurements against a 'yardstick'. As measurements became standardized, these sticks were compared with a common central reference. For example, the *metre* was a platinum-iridium bar kept at the Pavillon de Breteuil near Paris. In the 1960s, a laser superseded the metal reference, and today a *metre* is defined as 1,650,763.73 wavelengths of the orange-red emission line in the electromagnetic spectrum of krypton-86 in a vacuum. Measurement has become very precise!

Intelligence is different. It has no yardstick. If I were to ask, "How much intelligence does it take to design a building?" there's no simple answer. IQ is not an absolute measurement – it's a relative score. Test 100 people and list their scores in order. The ones in the middle get a score of 100; the top 5 a score of at least 130 and the top person a score of 140. Similarly at the lower end. A person with a high IQ is probably smarter than one with a low IQ, but it doesn't tell you if the building they designed will stand up. It's rather like quoting the odds of a horse winning the Derby. Quoting the odds does not give the speed of the horse, nor often the winner of the race!

Despite attempts by test creators to remove cultural bias, it can never be completely eliminated. Certain Amazonian tribes have no concept of counting above five. For them, numbers are an alien idea and serve no useful purpose in their habitat. In the jungle there are always enough trees to make spears, and as a hunter-gatherer you simply need to know where to find your prey. There is no need to count animals into an enclosure at night. Another interesting environment is the Australian Outback. Aboriginal Australians appear to have a remarkable aptitude for visio-spatial memory and can remember maps or collections of objects much better than you or I. Tests for this skill involve playing a variant of Pelmanism. A collection of objects is placed on a tray and covered with a cloth. The cloth is lifted for 60 seconds to reveal the location and type of objects and then replaced. Subjects are then given a bucket full of objects and asked to recreate the tray. You and I do a modest job. Native Australians do this almost perfectly. Why?

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In the vast, inhospitable Outback it is vitally important you remember that water can be found at the two rocks near the old gnarled tree. Forget this and you will die of thirst. It was once thought the skill evolved through natural selection, but this might not be the correct explanation. Recent studies show many of us can use mnemonic tricks to significantly improve our memory. Aboriginal skills might actually be learned and passed on from generation to generation.

IQ gives us a way to sum up intelligence using a single number but is this too simplistic? We all have friends who would be our first call if we met that special someone or lost our jobs. They are often not the smartest people we know, but they are highly empathetic. These people have 'social intelligence'. Other friends may fail academic tests yet demonstrate wonderful musical or artistic ability. They have creative intelligence. As we dig deeper, more talents emerge: sporting prowess, organizational brilliance, the ability to inspire loyalty. All these traits appear independently of academic brilliance.

During the last century, scientists worked hard to understand these different intelligence traits. The most influential theory came out of studies done at the United States Army Educational testing service, by Raymond Cattell and John Horn, and later added to by John Carroll. Their initials give the theory its name. CHC theory breaks down the general idea of intelligence into many different subgroups: 'G' factors.

If you are good at recalling all the kings and queens of England in chronological order, or can name every member of the 1966 English World Cup team or, perhaps, all the members of the baseball Hall of Fame, you would have high 'crystalized intelligence' – 'Gc'. It measures the sum total of all the *things* you have learned and retained in your long-term memory, your store of useful, and useless, facts. On the other hand there is innate intelligence, the sort that allows you to solve problems where tapping memory banks is not useful. My family often buy me puzzles for Christmas, the sort where you manipulate bits of bent metal that appear linked, but can be separated with a little ingenuity. These puzzles test our ability to work with problems we have never seen before and is called 'fluid intelligence' – 'Gf'.

Metal Puzzle

We can go further. A good tennis player will have high 'Gt' and 'Gv' scores: 't' for time and 'v' for vision, a good pub quiz

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contestant a high 'Glr' score – 'lr' denoting for long-term retrieval. Carol Vorderman, a UK game show presenter famous for mental arithmetic, would have a good 'Gq' score, 'q' for quantitative numerical skills. With all these types of intelligence to choose from it begs the question, "Is there a single master intelligence from which the rest follow?"

Political correctness plays a part here. It feels rather elitist to say smart people are good at everything. It is far nicer to think we each have our individual talents and some just have a few more than others. But that's not what the science tells us. 'Group Intelligence' – the overall G score – does appear to be the underlying cause of the other types of intelligence, and smart people do tend to be good all-rounders. However, there is one major flaw in the analysis; the studies only measure the subjects' ability to pass academic tests, they don't look at our success in real-life, nor our creativity.

Lewis Terman began the longest running study of intelligence and its relationship to life success back in the 1920s. It continues to this day. A group of 1500 children with high IQs were selected and tracked throughout their lives. Terman assumed their high IQs would result in them being very successful. They certainly did well, but studies show they did no better than if they had been chosen randomly from the same area (all the children came from around Stanford University). Famously two children, William Shockley and Luis Alvarez, tested too low to be chosen for the study but went on to win Nobel Prizes for Physics in 1956 and 1968, respectively.

There are many similar anecdotes: Apparently stupid people go on to great things. Einstein's teacher famously stated he would never amount to anything and Sir John Gurdon's school report said he was 'too stupid' for science. He went on to discover monoclonal antibodies for which he was awarded a Nobel Prize! Scientists have now devised the alternative theory of an intelligence tidemark. Once above this level – an IQ of about 130 – you can pretty much do anything you want to. This might be because one very important type of intelligence – creative intelligence – is not highly correlated with the rest. Creative people tend to be sufficiently intelligent for their field but once above that threshold the relationship breaks down. Success in creative endeavors seems to reflect strength of character and creative aptitude rather than raw brainpower.

Physical Basis of Intelligence

The high correlation between different sorts of academic intelligence suggests we might find a physical process within the brain leading to

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high IQ. Functional MRI scans show intelligent people use more neurons when tackling a given mental task, perhaps bringing to bear greater raw horsepower, but this is not really an explanation. It is akin to saying Usain Bolt runs faster because he gets more power to his legs. This is obvious. What we want to know is *how*.

The problem with looking at brains for a common cause is the variation from brain to brain. We all have different genes and life experiences. On top of this, we really only see brains post mortem and this tends to confound comparisons of brain structure. One way to minimize the variation is to use separated identical twins. Twins have identical genes so their fundamental hardware is the same. We should be able to see features of the brain that are common to smart sets of twins but absent in less smart pairs. If a feature is not shared it can be discounted as something accidental, caused by disease, environment, or the like.

When we examine smart twins, they appear to have greater myelination of their neurons. Myelin is a flat protein that acts as an insulating sheath, wrapping the nerves and the neurons in our brain. Myelination appears to be part of the mechanism involved in laying down long-term memory – more myelin, more memories. It may also help sustain signals and allow them to move faster over a longer distance: the increased insulation allowing the brain to include information from more distant parts of the brain within a given thought. But increased myelination may be an effect of higher intelligence rather than a cause. The brain is responsible for a significant part of our overall energy consumption so insulating the neurons might simply help with energy conservation. This is an active area of research.

Evolution also gives a clue to the causes of intelligence. Humans, nonhuman primates, and dolphins all share spindle neurons. These spread across the brain and appear to help us coordinate complex actions between the different parts. The high function intelligence that characterizes these disparate species requires a great deal of cooperation between different areas of the brain. Take playing a musical instrument. This uses physical coordination (motor cortex), sound processing (auditory cortex), rhythm (another part of the motor cortex), along with emotional interpretation (amygdala). Humans have more spindle cells than other animals so this might explain our superior ability in performing these complex tasks.

However plausible these ideas, they are all hardware arguments. It is like me saying my word processor is better than yours because it has gold plated connectors. That might be true – it might allow the machine to run a little faster without electrical errors creeping in, but we all know

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it's software that matters. A great computer game is great because it is cleverly written and has beautiful graphics. The speed of the hardware might help, but it does not define 'great'.

Can we see these software effects in the brain?

No, unfortunately, this is where our imaging technologies fail. They lack sufficient resolution. We would need 100,000 times more resolution to see our thoughts, even assuming we would recognize thought if we saw it. There is no reason to believe the brain lays out thinking in anything resembling the computer software we are accustomed to reading.

There is one exceptional group of people that *does* show a software difference on a large-scale – chess players. It seems Chess Masters use a different part of their brain to process information about chess than you and I. This can be clearly seen on scans of the brain and is such a gross effect it even shows up in old-fashioned EEGs – where electrodes are taped to your head. Interestingly the effect can be used to predict greatness. Players likely to become Grand Masters show they use a different part of their brain from the rest of us at an early age. Chess players possess the only large scale *wiring* difference we know of, but there is another group with a visible physical difference, London taxi drivers. Their hippocampi are noticeably larger than the rest of ours. The hippocampus does many things, but one of its most significant jobs is to memorize maps. The three years it takes to acquire 'the knowledge' and the subsequent years of navigating London's complex streets give cabbies a 30% larger hippocampus than the average London resident.

Is Intelligence Static?

We've all seen the headline. Every summer public examination results come out and every year is pronounced a record breaker! Year after year, students get better and better grades. This creates a problem. There's is no better grade than an A – and eventually all students get As. Welcome to grade inflation – a problem affecting systems the world over, from British 'A' levels to Harvard grade point averages. Newspapers are awash with stories bemoaning the dumbing down of today's tests. "Examinations aren't what they used to be."

Grade inflation undoubtedly exists and studies of undergraduate grades show progressive compression into the top grades, most competent students get 'A's, making it difficult to distinguish a good student from a great one.

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At first glance, the problem appears to be one of social engineering. Teachers don't want to disappoint, and academic institutions want to improve on last year's results. The people awarding the grades often have a vested interest in those grades improving. Even a tiny positive bias in the most scrupulously honest teacher is enough for grades to creep up. However, grade inflation might not be purely a matter of over enthusiastic teachers. IQ scores are also rising. Welcome to the Flynn Effect.

James Flynn, Emeritus Professor of Political Studies at the University of Otago in Dunedin, New Zealand, reported in 1987 that IQ scores rise over time throughout the world. All told the population gains about one IQ point every three years, and approximately every ten years IQ tests have to be re-calibrated, so the average student once again receives the average grade. This is a mystery. It is a large effect and cannot be explained by the rote learning of lots of sample questions. The human race is either rapidly getting smarter or the least smart members of society are coming up to the general average fast; either way it means there are fewer dumb people around. The Flynn Effect has recently slowed in western countries, suggesting it might be that intelligence is converging rather than increasing overall. Another interesting fact is people become more intelligent as they age, gaining about one IQ point every ten years. Against the stereotype, it's not all downhill after forty. There is hope for me yet!

Until recently we thought IQ was fixed, but new research contradicts this. Muscles get stronger with exercise, physical skills, such as playing golf and tennis, improve with practice; why not intelligence? Scientists used to believe brains couldn't get smarter; you had the IQ you were born with. You might learn more 'stuff' during your life, but the G factor stayed the same. It looks like this is wrong and we were simply not using the right exercises.

In 2008, Susanne Jaeggi and Martin Buschkuehl, of the University of Maryland, modified an intelligence test into a game and showed playing the game improved 'fluid' intelligence and increases IQ. They believe playing their game helps improve working memory – the short-term memory we use for storing sums as we do mental arithmetic – or remembering telephone numbers. Previous attempts to improve IQ through practice had not shown much success as the skills did not transfer between tests, but working memory is such a useful thing it appears to help across the board.

These factors argue against intelligence being a hardware feature of our brain. It does not remain static but instead improves with age, time, and education.

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At the beginning of the chapter, I said Garry Kasparov was once thought to be one of the most intelligent people on the planet. When his IQ was eventually tested – the German magazine *Der Spiegel* put up the money – he scored 135. That means, in academic terms, he is smart but no genius. Yet, he is undoubtedly a genius by any common sense definition: the best chess player to ever live. These days he involves himself in politics rather than chess and is still uniquely able to concentrate for long periods of time. Concentration seems a very important factor. Einstein was once asked where his genius came from. He replied that he did not consider himself a genius but instead put his success down to his persistence and ability to concentrate on a problem for many years. IQ tests say nothing of our ability to concentrate over extended periods and nothing about our drive to change the world. The tests are, at best, a useful but dangerous diagnostic tool for educators. One of the worst things IQ can do is pigeonhole people. Would Kasparov have become world champion if he had been given his IQ score of 135 as a teenager rather than late in his thirties after he had conquered the world?

Hole-in-the-Wall Experiment

"Education is what is left after what has been learnt has been forgotten."

B.F. Skinner

The Learning Brain

Human beings are born with an extraordinary ability to learn through experiencing the world around them. Studies show babies as young as three weeks understand musical ideas, smiling as you play music to them in a major key and frowning at music in a minor key. By six months, babies have learned to distinguish the relationship between objects, and by two, they have a command of language and are beginning to develop a theory of self. They understand how to lie and become adept at playing parents off against each other!

Sugata Mitra, of Newcastle University, has run an experiment in India to test minimally invasive education called the 'Hole in the Wall Project'. As the name suggests, he cut a hole in the wall of a building in Delhi and put a computer in it. The hole opens out onto a slum district and local children rapidly discovered the computer. Without any formal training they picked up the necessary skills and very soon became adept at searching the Web. Remember, in order to 'pick up' this skill they often had to learn the English language as well.

Another example showing children's innate ability to learn is Nicolas Negroponte's 'One Laptop per Child' program, which gives computers to children in remote villages around the world. The laptops are a triumph of cost engineering but are fully functional and can connect to the Internet. The inspiration for the project came from an analysis of the economics of the computer industry. Huge capital investment in the western world is driving most costs down, but one cost that seems to have stuck fast is the access device. Laptops tend to remain at a floor price of around $500, far too high for much of the developing world. At $500, a computer store makes $80 when they sell you a laptop. This is as low as is cost-effective

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Laptops Galore

for them to stock the machine, employ someone to tell you about it, and fix it if it goes wrong in the first year. Value for money improvements have all focused on faster processors, more memory, sharper displays and larger hard drives, not lower prices. These improvements are useful if you want to shoot aliens, but overkill if you only want to surf the Internet and learn the '3 Rs'. So the 'One Laptop per Child' project has developed a device for $100.

Negroponte is often asked how he deals with the maintenance and repair issues. His answer, "There aren't any." The computers are treasured possessions and rarely broken or lost. Children become empowered by the machines and can access knowledge and information far beyond the wildest dreams of their parents' generation. Stories abound of children checking the spot prices for wheat or coffee on the Chicago Stock Exchange, and advising their parents on the price to accept for their crop. Negroponte estimates there are currently 500,000 children in South America teaching their parents to read!

It's interesting to speculate whether children learn spontaneously or are somehow 'programmed' by the adult members of society. In both the 'Hole in the Wall' experiment and the 'One Laptop per Child' program the children could simply be learning from adults and older children, but there is a novel way to eliminate this influence. Negroponte and Mitra have teamed up to run an experiment to see how children learn for themselves. They are planning to air-drop laptops into remote villages in the Andes. In this scenario, the children can't possibly learn from the

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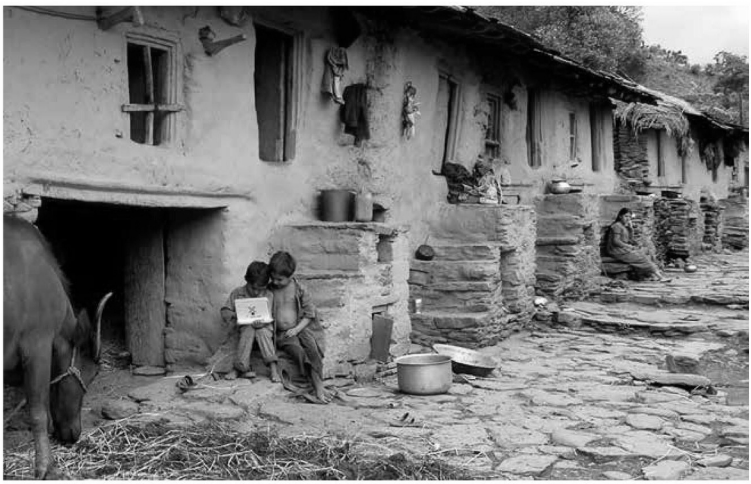

One Laptop per Child

adults – the adults have never even seen a computer before. Instead, they must rely entirely on their innate learning ability. At this point, the experiment has only just started; I will put details on my website as the experiment progresses.

The 10,000 Hour Club

Learning by experience takes humans quite a bit of time. Anders Ericsson, Professor of Psychology at Florida State University, studied musicians in the early 1990s and found they had accumulated a huge number of practice hours by the time they became experts. His research was popularized by Malcolm Gladwell, in the book *Outliers*, and by Daniel Coyle in *The Talent Code*. The idea is that humans need around ten thousand hours of practice to become proficient at a skill. The more skilled players seem to have simply accumulated even more

Dan McLaughlin

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practice. A number of people have wondered whether you can take this literally, and if you devote 10,000 hours to practicing something you can become world class. Dan McLaughlin from the USA used to be a professional photographer and decided he might like to become a professional golfer. He quit his job and is now 3,500 hours in. So far, he has achieved a 4 handicap. I also personally got bitten by this bug and am learning the piano. I am about 3,000 hours in and am making good progress.

Piano Practice

Gladwell's interpretation of Ericsson's results is not without controversy. Ericsson stresses 'purposeful practice' is the important element. Practicing the wrong thing for ten thousand hours will just make you good at doing something wrong. Practicing without concentration and attention will equally have little effect. One illustrative example is the story of Edward Sanford, a supreme court judge, who read the morning prayer aloud every day over a 25 year period. After he retired he was asked if he could recite it from memory. Despite reading it as many as 5000 times during his working life, he was unable to remember it. It seems you must purposefully practice the exact thing you want to do if you wish to learn it, in this case recall.

Computers don't require practice to learn a skill. If their program is right they work correctly, and if it is wrong, they are always wrong. Computers can be programmed to learn but so far this learning has been limited to specific problem domains, such as face recognition. They do not have the general-purpose capability humans enjoy.

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Astrological Clock at Hampton Court Palace

"The die is cast"

Shakespeare

"How does the water of the brain turn into the wine of consciousness?"

David Chalmers

Determinism

I have free will.

Look…

I can choose to type any word I like.

Giotto...

Many philosophers tell me I am deluded. I was always going to type that word and I have no free will. Everything in my life is predetermined. I'm rather like a character in an enormous video game. The character might think it was free to act, and its actions would appear random. Yet from the moment the player clicked the button to start the game, every action the character takes is determined by a preprogrammed set of rules. This is the free will debate. How can we tell we are free? Would there be any observable effect?

One of the big problems is that philosophers codified much of our modern theory of free will in the 19th century, at a time when all the known physical laws were deterministic and reversible. They could not see a way for free will to emerge from such physical laws. There was even a group called the Compatibilists lead by David Hume that thought free will could coexist with determinism. Provided you felt free it did not matter that your actions were inevitable.

We all want free will to mean actual freedom to make conscious choices. We would like to affect the world in which we live; not the other way around. I dislike making definitions – I find they take away from the core argument and only result in linguistic jousting, but it seems that two centuries of philosophers have avoided a proper discussion of free will by loosely defining the term. Here is my definition:

'We consciously, and through the exercise of will, make decisions between different choices without anyone or anything causing the decision in advance. Others can influence decisions – by offering advice or even holding a gun to our head, but we choose.'

If you can devise a better, stronger definition please email me and I will revise my definition to your better one. I'm searching for the most powerful definition of free will – totally free and born out of the exercise of will.

The human mind appears to have free will. At least this is my personal conscious experience. Computers, on the other hand, do not. They run programs that dictate exactly how they will operate in every situation. Could a computer be programmed to have free will? That's hard to do. Let's see why.

Thinking with Clockwork

Astronomers have been predicting the motions of the heavens for centuries and to do this they need accurate clocks. The very first clocks were sundials. These suffered the obvious disadvantage of not working at night, but it was also unsatisfactory to use the motion of the sun to predict the motion of the sun. The earliest 'heaven independent' clocks used water flowing through small holes in pottery vessels. They were effective over short intervals but plagued by dust, dirt and evaporation. It was the invention of the anchor escapement that enabled the first accurate mechanical clocks.

By the sixteenth century clockmakers had gone to town developing astrological clocks with more and more gears, to show all manner of information; the phases of the moon, the motions of planets, even the motion of moons orbiting those planets. These clocks became hugely ornate. The astrological clock at Hampton Court Palace was built for Henry VIII circa 1542 and, as well as showing phases of the moon and the signs of the zodiac, it accurately calculated the time of high tide at London Bridge, allowing Henry to travel quickly to the Tower of London. You might also notice it shows the sun orbiting the earth! Copernicus published his book, *De revolutionibus orbium coelestium (On the Revolutions of the Celestial Spheres)* showing the earth orbited the sun a year later in 1543, and it took centuries before it became accepted fact.

Clocks need gears. The humble gear is a simple machine. They work because wheels of different size have different circumferences – the distance around the edge – but one full turn is the same for all wheels. Imagine you have a circular sweet such as a Life Saver – or Polo for

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British readers – and you roll it once around the wheel of your car. The small sweet will turn many times. Now put a pencil through the hole in the sweet, jack up your car so the wheel is off the ground, hold the sweet next to the wheel of your car and press the accelerator. The sweet will spin round very fast and probably disintegrate in a shower of minty sugar. This is the principle of gearing. A small circle has to do a lot of work to keep up with a big circle. It's very predictable. The sweet will turn a set number of times for each rotation of the car wheel, equal to the ratio of the circumferences of the two circles.

Gears usually have teeth to lock the wheels together, but this is really just to make sure they can't slip against one another when they transfer huge forces, such as in racing cars. Some passenger cars have been built with smooth gears; a friend of mine had one at university. If he put his foot down too hard, the gears would slip, heat up and you would get a terrific smell of burning rubber. If you were lucky you could leave the car for a few hours and all would be well. But, if not, you had to replace the rubber belt, which was very expensive. Toothed gears generally win out.

Toothed gears also have the enormous benefit of being digital. This is quite important if you want to keep things accurate. Gears can't move a fraction of a tooth so if a toothed gear has 'slipped' forward a small amount, it will be kicked back into position when it meshes with another gear.

In a modern mechanical clock, a balance wheel swings back and forth on a spring and moves the main gear one notch forward each time it passes its central position. Gears divide this down to move the hour and minute hands. If I put the hands of a clock at midday and let the clock tick 86,400 times, the clock hands will come back to the same place. Once you understand how a clock works you can play a trick. If you tell me the number of ticks the clock has tocked, I can tell you the exact position the hands will be in. To a small child this might be dressed up as a magicians trick – but, of course, it is simply a matter of dividing the number of ticks by 60 and then 60 again to calculate the amount of time elapsed. This type of precisely predictable behavior is called deterministic behavior. Something is deterministic if you can set it up in a particular way and know the exact state later or, conversely, examine something and trace it back into the past.

Modern computers scale up clockwork and make it much more efficient; gears are translated into electronic logic gates and a quartz crystal vibrates at 1000 million ticks per second to give us the clock tick. On each tick, the computer can do a mathematical operation, store and retrieve information, or branch down an avenue in its program. Using

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these simple building blocks the computer allows us to play computer games or process the words of this book as I write. Importantly, all these operations are deterministic; given a set of inputs the computer will always generate the same outputs and that means a computer has no free will.

"Ah," I hear you say, "but my computer plays games with me and is not predictable, otherwise I would always beat it." You are right, but the computer has a clever trick to fake non-deterministic behavior: it uses you!

Computers on their own cannot generate random numbers. All a computer can do is generate a pseudo-random number and it does this by working its way through a very long calculation. It could, for example, calculate the first thousand digits of π (pi), and then start using the subsequent digits as random numbers. The digits look jumbled up but we know they follow an entirely predictable pattern. The computer appears to behave randomly because when I press the button to kill an alien the computer picks the number it had counted up to at that moment, say the 55,678th digit of π, and uses that. It is I, the human, who unconsciously picks the precise moment in time and therefore provides the random element. My choice is governed by all sorts of extraneous quantum influences: Did I have coffee this morning? Was it a big mug or a small cup? How hot was it? All these things will be important as they determine the amount of caffeine absorbed across the brain blood barrier and the exact timing of my actions.

Humans are not good at consciously generating random numbers. We tend to choose the same numbers too often. If I ask you to pick a number between one and ten, you are likely to choose three or seven. This effect is called social stereotyping; magicians often use it when they pretend to read your mind. The problem arises because we tend to over think the problem. I asked you to pick a random number between one and ten. You won't pick one or ten. Five is too obviously the mid-point. Even numbers don't feel random. Nine is too large. That just leaves three and seven. So the mind reading magician has you! Humans can unlearn this social programming and become quite good random number generators but normally we tend to conform.

There is a way two humans can generate a truly random number without training. Find a friend for this experiment. One of you should pick any number between one and ten and start counting under your breath, when you get to ten just go back to one and keep repeating. The other should wait a while and then shout stop. The number reached should be genuinely random. Please post the results on my website and I'll tell

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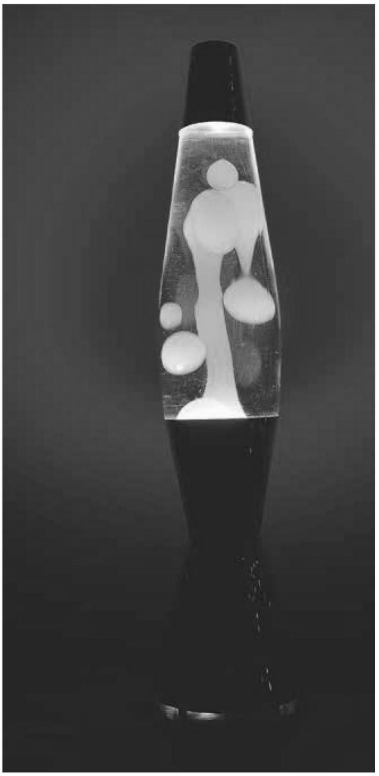
you if this crowd-sourced random number generator really works. There should be no way to predict the resulting number as both of you are affected by quantum randomness and, provided you wait a little before shouting stop, any social stereotyping should be overcome. If you want to be scientific, remember the random number you started with and the length of time before your friend shouted stop. There should be an improvement in randomness with the amount of time they wait.



Lava Lamp

In the absence of human interaction another way to give a computer access to a random number is from a quantum device. A lava lamp works well! The Lavarand, developed by Silicon Graphics, is a hardware random number generator which uses images of a lava lamp to seed a random number generator. It is covered by U.S. Patent 5,732,138, titled "Method for seeding a pseudo-random number generator with a cryptographic hash of a digitization of a chaotic system." Got that!

A computer does not acquire free will just through the injection of randomness. You could simply put an intercept on the link from the lava lamp to the computer and completely predict the computer's behavior. The system as a whole will certainly do unpredictable things, but the computer did not make a choice; behaving randomly is not exercising free will. Where is the will?

Consciousness

I remember my first trip to Death Valley in the United States. We were driving along the main east-west highway at the bottom of the valley and a sign said, "Turn off your air conditioning now." I did as I was told and to cool down I opened the window. When I put my hand out I felt

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nothing; no wind chill, nothing. The air was so hot the wind carried no heat from my hand. When I imagine hot weather it always brings back this memory. It's my conscious experience of the world.

Humans experience the world through a vivid lens we call consciousness. It allows us to think about the world as we watch it and plan actions. But, it also summons associated memories, something scientists call 'qualia'. Most writers describe consciousness as an internal dialogue with themselves and see it as a consequence of human language. That's probably because most writers are linguists. Non-linguists, perhaps even dyslexic engineers like me, experience consciousness as more of a visual dialogue.

It's hard to pin down consciousness as the difference between humans and computers. Computers do have something that resembles consciousness; they have watchdog functions, they plan and anticipate actions and are aware of their own existence. But they don't understand or make free choices based on this consciousness. It is an entirely mechanistic affair. A computer might know its CPU is overheating and send a notification message to the administrator, but it does not really appreciate what this means. It does not have our sensation of a near death experience. This self-awareness is the 'hard question' of consciousness. Why, despite the computer knowing it is overheating, does this not translate into the intense experience we have? Philosophers, such as Daniel Dennett, think this lack of consciousness is only a matter of time; once computers live long enough and have sufficient internal complexity they will begin to experience the world the way we do. We are nothing special.

The problem with consciousness is it does not seem to have any externally discernible effect. Anesthetics can take it away and brain scanners can see that it has been switched off, but what is it for? I think it comes hand in hand with our faculty of creativity. Consciousness allows us to shape the world – not the other way round.

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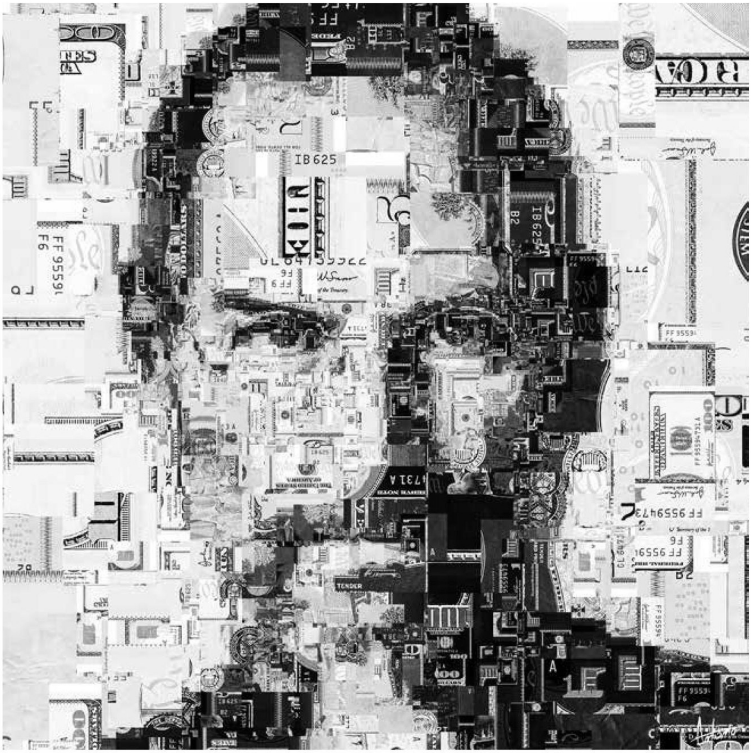

Steve Jobs

"We can't solve problems by using the same kind of thinking we used when we created them."

Albert Einstein

Creative Theories

Once I have exercised my free will by getting out of bed in the morning, I often decide to do something creative. Humans seem driven to create. We compose music, draw, paint, and solve mathematical puzzles. Computers are not naturally creative; they spend most of their time doing exactly the opposite – following preset rules. Is this a fundamental limitation distinguishing the computational world from the real world?

The Conventional View

Most scientists believe pattern-matching algorithms in the brain allow us to be creative. To see how this might work, imagine our brains are chaotic – not hard to do – and process many competing ideas at the same time. The neurons in our brains build millions of useful, and useless, connections based on the patterns in the data we see and hear. Then a selection process goes to work – something akin to natural selection – to sift and prune the connections until something bubbles to the surface and we get that, 'aha' feeling.

Douglas Hofstadter, Professor of Cognitive Science at Indiana University, famous for the book *Gödel Escher Bach*, has written a computer program using pattern matching to discover number theorems; things like any number ending in a zero is divisible by 5. The program produces interesting results, even perhaps generating some new theorems. He argues the human brain is essentially a scaled up version of his program. By the way, if you like trivia, his book *Fluid Concepts & Creative Analogies* was the first book ever sold on Amazon.com.

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The Unconventional View

Roger Penrose, Professor of Mathematics at Oxford University, holds a completely different view. He thinks brains operate in a non-algorithmic manner and provides a sketch of the possible mechanism in two books – *The Emperor's New Mind* and *Shadows of the Mind*. He suggests tubulin molecules, which form the skeleton of our neurons, exploit quantum-gravitational effects to calculate non-computable functions. The scientific community was initially highly skeptical that quantum effects could survive the warm, wet environment of biological systems, but in January of 2014, Edward O'Reilly and others at UCL discovered plants use quantum effects to improve the efficiency of photosynthesis. No prize has yet been awarded for this discovery but it must be a contender for a Nobel Prize at some point. Recently Travis Craddock, now of the Nova Institute in Florida, has submitted a paper showing a very similar geometry of proteins exists within tubulin microtubules in the brain. He believes this is evidence quantum effects may exist there as well.

A simple quantum effect in the brain could merely reduce the resistance of the wiring in the brain to help conserve power and avoid overheating. We recognize this is a major problem in building small, powerful conventional computers. Roger Penrose suggests an altogether more radical idea. He proposes our brains are quantum gravity computers capable of calculating non-computable functions. We don't yet have a theory for quantum gravity so his idea is at the cutting edge of physics – read highly controversial. He raises a deep mathematical question. If the Universe is deterministic and effectively equivalent to a computation, how does 'creative' knowledge emerge within it? Lots of knowledge can be manufactured by simply mechanically rearranging data. That's what happens when I watch a DVD or play a computer game, but, at some point in the past, a director or a programmer had to put in the creative effort to make the movie or write the computer program. How did that happen? Was it baked into the fabric of the Universe at the moment of the Big Bang? Is what we take for a Universe really nothing more complex than putting a DVD in the slot and hitting play?

One last piece of trivia links Hofstadter with Penrose: Roger Penrose and his father invented the Penrose Steps, inspiring the never-ending staircase in the Escher prints featured in Hofstadter's book. For movie buffs, the Penrose steps appear in the film *Inception*, starring Leonardo DiCaprio. The fact we get pleasure from these trivial links tells me something is going on in our brains that is not so mechanical.

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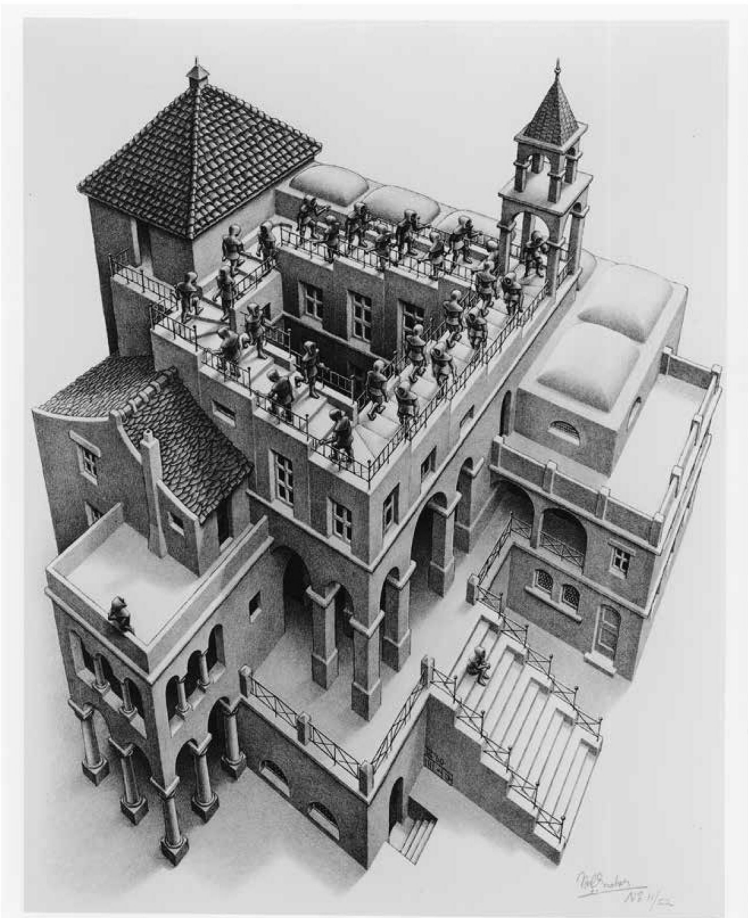

M. C. Escher's Ascending and Descending (Penrose Steps)

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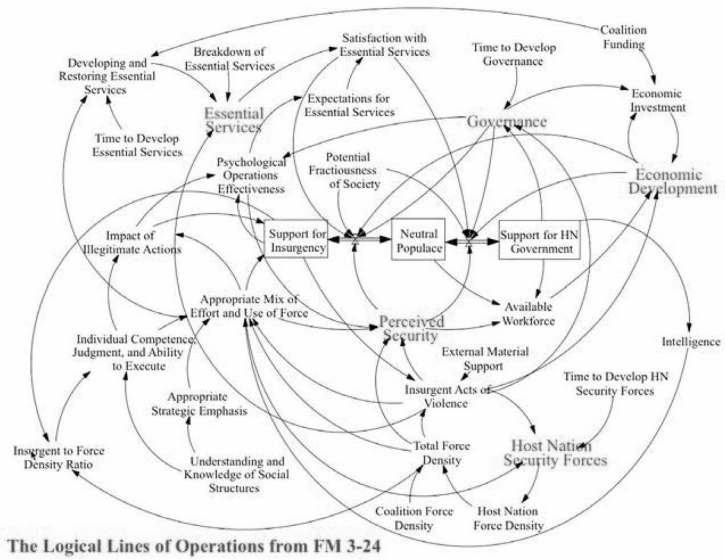
Chapter 2

UNDERSTANDING



The Logical Lines of Operations from FM 3-24

Afghanistan COIN Dynamics

"Power corrupts, PowerPoint corrupts absolutely."

Ed Tufte

"No battle plan survives contact with the enemy."

Colin Powell
Originally, Helmuth von Moltke

John Masters stood up to address General Stanley A. McChrystal and his military staff in Kabul. The topic, of course, the war in Afghanistan. The main war lasted only eight weeks, but this did not end the conflict. A level of tribal violence and insurgent warfare rumbled on for years, killing around 30 people a week. Masters' job was to explain the dynamics of Afghanistan and provide politicians and military commanders a framework to understand what was going on.

Think about your country for a moment. What maintains the fabric of society – police, family, the local charity club, church, newspapers, the broadcast media? All these institutions work to keep us civilized, but what happens if a country loses them? There are institutions in Afghanistan, good and bad: tribes, gangs, corrupt officials, families. Masters had spent a year investigating these interactions, and questioning the returning commanders. He and his team believed that understanding the dynamics of the conflict was the key to bringing peace to Afghanistan.

If you live in an industrialized country, you rarely see society without its civilizing web in place. One interesting 'experiment' that shows what happens when it fails was the 1976 traffic police strike in Finland. Finland is a fantastically law abiding country where most people obey both the written and unwritten laws. During the strike, this behavior changed. Many people began parking illegally but refrained from blocking the roads. A few took advantage of the absence of police to drive incredibly fast – twice the national limit. These would be labeled as 'defectors' in game theory. Without traffic police, a different automotive

General Stanley A. McChrystal

morality emerged, a different structure to society. Of course all the other parts of society remained the same. People paid their taxes and went about their lives normally; only the traffic behavior was affected.

Afghanistan has had most of its social structures removed over the last forty or so years. First the Soviets, and then the Taliban, took apart much of the fabric until finally the Allied Forces swept the Taliban out, leaving very little behind. There were no police or courts, and few laws – or at least none enforced by the rule of law. The Allied Forces have spent a decade rebuilding these structures. Before we examine Masters' presentation, let's look at the daily life of an Afghan farmer.

If you are an Afghan farmer you have a dilemma. Your most reliable crop is opium. It grows well in the arid soil, does not require irrigation, and is resistant to most pests. For this crop there is a financial infrastructure to rival the Chicago Commodities Exchange. You get interest free loans secured against the crop, and you can forward sell your product on a futures market. Your investors can 'add value' by dealing with the major pest – the US military. They do this through the simple expedience of taking pot shots at them if they get too close to the crop. Since a field of opium is worth $30,000 and a militia wage for the year is $350, you can easily employ a few men to protect your investment. Of course, you are indebted to thugs and criminals, but they are at least reliable thugs and criminals.

On the other hand, the traditional products of the Himalayas – walnuts, pomegranates and vines – need years to cultivate. There is no forward market and the timescales over which you must take risks are far greater. If you believe your American protectors will leave before the crops mature, you will be loath to plant and care for them. But, if you make the decision to take this risk, you have a strong incentive to foster stability and reap the rewards of your effort. There is a feedback effect: the balance of power between all the different parties is important to the decisions you make, and the decisions you make affect your desire to invest in future stability.

Masters' team built a slide pack to demonstrate the complex interactions between the groups: farmers, security, stability, markets, military power, and emerging institutions. The COIN – COunter INsurgency – dynamics slide shows just how hard it is to communicate complex topics between human beings. The presentation is beautifully crafted but it was a public relations disaster. At the end of the presentation General McChrystal said jokingly, "When we understand that slide, we will have won the war." The slide was paraded in the press as, "the most complicated PowerPoint slide in history."

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If you invest a little time on the slide you will understand it and may even see it as a thing of beauty. But Masters' audience was obviously expecting something different and, presented with this level of complexity, went into shutdown. Perhaps they wanted a simpler presentation, a high-level summary, a few bullet points. Of course, there is no simple presentation on Afghanistan. The lesson is that context, timing and expectation are often as important to good communication as the elegance of the content, and that information is a complex thing.

If you want a lighthearted poke at PowerPoint here is Peter Norvig's PowerPoint version of the Gettysburg Address.

Understanding

Next time you are in a business meeting, count the number of times the word 'understand' is used. If you ask the people around you what it means you'll stump many of them. That's because understanding has two very different meanings. Most people don't separate these meanings but the distinction is important. Understanding means to decode information, to comprehend – but, more importantly, it also means to absorb and internalize information. That feeling you have when you 'get it'.

If I say, "I understand" I mean I have taken in the question you asked and decoded it into ideas so I can provide an answer. This can be quite a mechanical process and computers routinely understand natural language and answer questions – Apple's digital assistant Siri being a case in point.

When I say, "I understand a problem" or "understand a culture" I mean something far less tangible. Somehow the information I have gathered over my life is formed into a matrix within my brain that allows me to ponder and run scenarios. I can predict the effects of my actions before I do them, and often anticipate your responses. That's clearly a very useful evolutionary adaption, but is there more to it than that? Roger Penrose and David Deutsch think understanding allows us to transfer non-symbolic information from one brain to another. We don't run programs in our brains, nor do we store precise information such as lists and tables. We have, therefore, had to evolve a creative approach to communicating skills and understanding each other. One of the most closely studied areas in the field of communication is when it breaks down in the lead up to a disaster.

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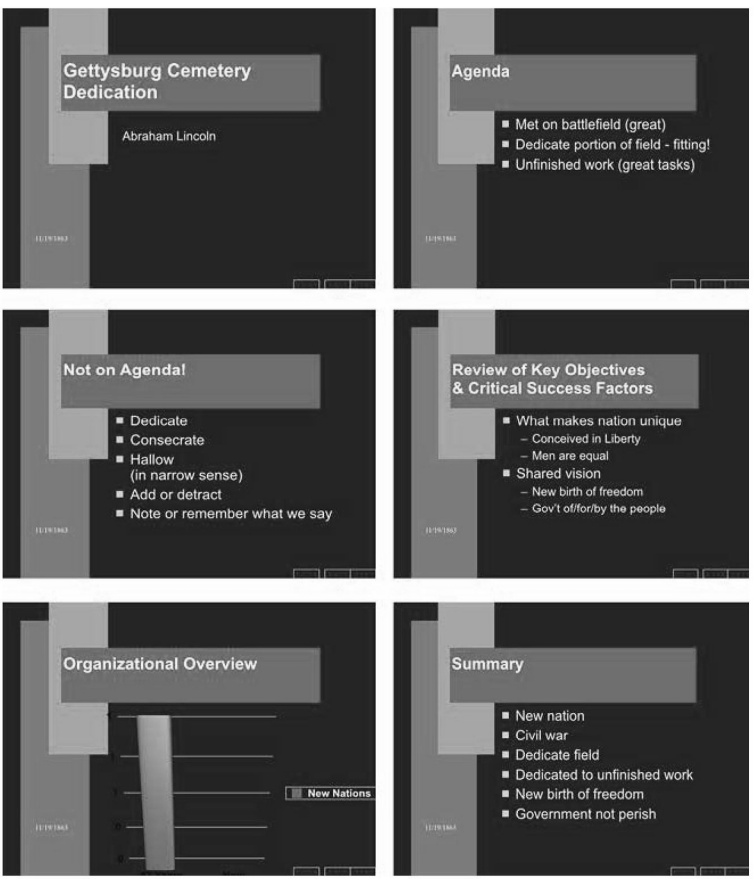
"The human mind tends to look for clear linear relationships, we like solutions that are close to the problem in time and space and make sense when we think about it quickly, unfortunately, those simple solutions are usually wrong and come from acting on a complex system as if it was a simple one."

Brett Piersen



Gettysburg Address, Peter Norvig

Space Shuttle Columbia Crew Photo

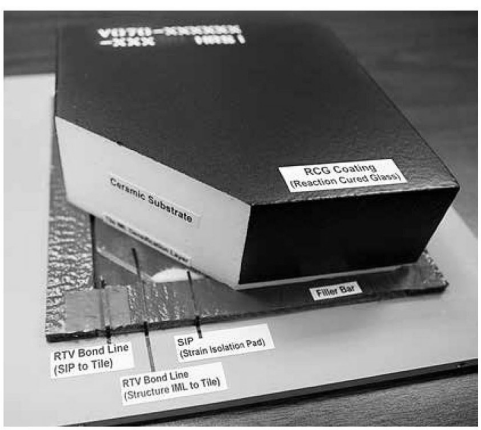
"For a successful technology, reality must take precedence over public relations, for Nature cannot be fooled."

Richard Feynman

Bad Understanding Can Kill

On January 16, 2003, at 3:39pm, the Columbia space shuttle took off from Cape Canaveral. During the launch a small piece of foam insulation broke off the fuel tank and hit the shuttlecraft. The event was recorded on a few low-resolution video frames. They show a tiny white object hitting the shuttle and a plume of dusty material splattering outward. The shuttle made it safely into orbit and for two weeks engineers on the ground debated what to do. In the end, it was decided the risk was minimal and the shuttle could safely return to Earth. On reentry, the shuttle disintegrated, killing seven astronauts.

NASA managers had decided the shuttle was undamaged based on a series of presentations by the engineers. One image in particular analyzed the potential damage to the shuttle's tiles from an impact. Read the slide, look at the key frames, and decide for yourself what action you would have taken.



Shuttle Tile

Review of Test Data Indicates Conservatism for Tile Penetration

- **The existing SOFI on tile test data used to create Crater was reviewed along with STS-87 Southwest Research data**
  - **Crater overpredicted penetration of tile coating significantly**
    - **Initial penetration to described by normal velocity**
      - Varies with volume/mass of projectile (e.g., 200ft/sec for 3cu. In)
    - **Significant energy is required for the softer SOFI particle to penetrate the relatively hard tile coating**
      - Test results do show that it is possible at sufficient mass and velocity
    - **Conversely, once tile is penetrated SOFI can cause significant damage**
      - Minor variations in total energy (above penetration level) can cause significant tile damage
  - **Flight condition is significantly outside of test database**
    - **Volume of ramp is 1920cu in vs 3 cu in for test**

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NASA Internal Slide

WHAT DO YOU UNDERSTAND FROM THE SLIDE?

Some images of the launch are shown on the right

Here is what you should have understood from the slide: tiles are really tough but if the foam dislodged from the fuel tank broke through the outer coating it would cause significant damage. The estimated speed of the foam hitting the tile was 640 times greater than anything previously tested. Worried?

Is this a proper understanding of the problem? You have the slide and the images. Take another look and think hard. If you want, you can check a video of a similar launch on YouTube to get a feel for the scale of things, but the still frames shown all the information you need to make your conclusion.

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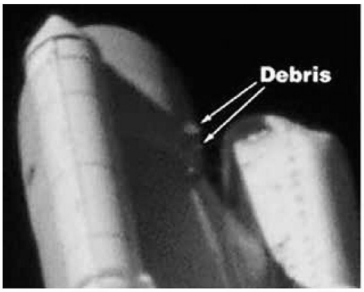
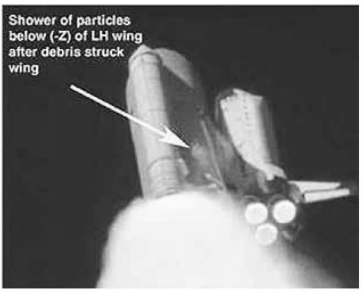
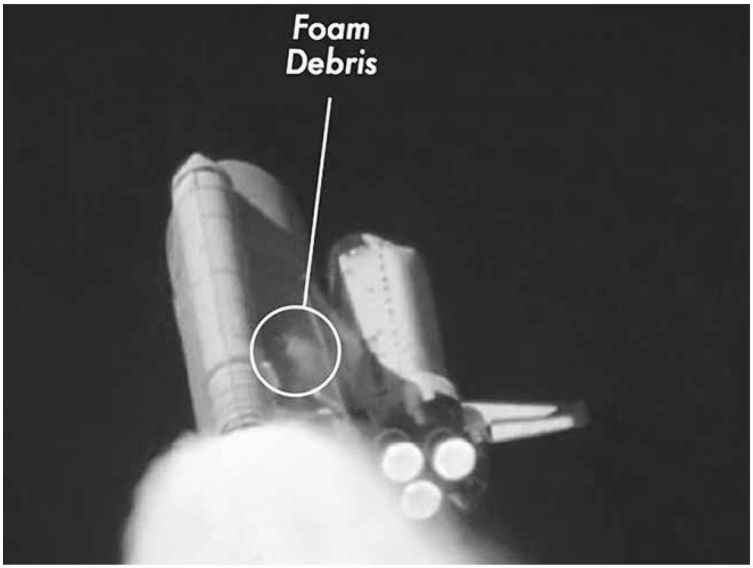




Photographs of the Foam Impact from Video Footage

Frame Showing Foam Dislodging



Still from Ground Camera

LOOK AT THE IMAGES, WHAT HAPPENED?

The truth is you simply don't know. If you are puzzling over the strength of tiles, you have been misdirected. There is video footage of some sort of impact on a wing mostly covered in white tiles, and a slide describing the effect of a benign sounding 'foam' hitting those tiles. But what is the evidence for an impact on a tile? The shuttle is certainly not made entirely from tiles; I can see a window in the picture. You should instead be asking more questions, "What happened?" "What hit what?" and "How bad is that?"

It was bad. The foam, a very tough material, had hit the leading edge of the wing, a weak point, punching a hole through it. The wing failed on reentry and tore the shuttle apart. Clearly, a full discussion of the possibilities did not occur amongst the shuttle team, or perhaps it only happened amongst the engineers in private. Once the analysis was tidied up and presented to 'management' it was a one-way communication of the conclusions, not a discussion of the underlying ambiguous thought process. The result: people passively listened to the information rather

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than interactively understanding it and agreed on the recommendation that it was safe to return. Clearly they did not understand the ambiguity otherwise they would have realized they did not have enough information to form a conclusion. This is the tragedy of lack of understanding. If they had known how little they knew, they could have deployed a spy satellite to take pictures of the damage – one was available nearby and would have taken a few hours to re-task – but they did not.

Ed Tufte served on the second shuttle disaster commission and provided an analysis of the disaster. He views slides as a poor medium for communicating complex problems and thinks documents are far better. The danger with slides is they force you to simplify information in a way that destroys the essence of the information. His analysis of the failure of communication at NASA formed a major part of the final report on the disaster. Later he coined the paraphrase "All Power corrupts; PowerPoint corrupts absolutely." Good communication benefits from stories and narrative, not bullet points and graphic fluff. Instead of using bullet points, speak! After all, we have evolved for 250,000 years to understand language, but only 25 to read PowerPoints. '

If you write presentations, Ed Tufte's book *The Cognitive Style of PowerPoint* is compulsory reading. He argues that much of the information you want to communicate is complex and interconnected. PowerPoint or any similar presentation software encourages you to simplify it into hierarchical bullets. The format implies simple causal relationships where none exists. This is dangerous. Communication should convey understanding – which is very important – and not just information. What, you ask, is the difference?

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Searle's Chinese Room

"The hardest thing to understand is why we can understand anything at all."

Albert Einstein

The Imitation Game

As an experiment, I am going to ask a student to spend a week in a locked room. The room is perfectly nice; it has a bed, a light, a desk, some reading matter, oh, and we'll give him some washing facilities too! Every now and then I post some food under the door to keep him going, Pop-tarts and pizza (thin-crust) work well.

On the first evening a note is pushed under his door with a symbol on it. The student puzzles for a while, then opens the book sitting on the desk. The book says, "If you get a piece of paper with symbols on it look them up and follow the instructions." He looks up the symbols and the entry in the book says, "Go to page 44, write down the third symbol on a piece of paper then post it back under the door." He follows the instruction and is rewarded with another piece of paper, this time with a larger set of symbols on it. Again he follows the instructions in the book and posts his answer back under the door. This goes on for several days. He is somewhat bemused, but it passes the time, and he diligently looks up the symbols and performs all the complicated actions as instructed.

Meanwhile, I meet our new Chinese graduate student and explain to her she needs to interview a potential translator for the department. He has just come in from Hong Kong and there is a health scare, so we have quarantined him in the lab room. He is bored and I have some paper for writing messages. She writes "hello" in Chinese on a piece of paper and posts it under the door.

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The exchange of notes goes on for a few days and the two seem to be getting on well. There is even a little romance in the air. When the week is over I open the door and the two meet. The graduate student says, "Hello. It's nice to finally meet you in person." The man is puzzled because, of course, she has spoken to him in Chinese. He knows no Chinese.

"I'm terribly sorry, but I don't speak Chinese," he says.

She is puzzled, "But I spoke with you this last week!"

"No, I really don't speak it," he says.

And, of course, he is telling the truth. The book he has been using contains the rules for answering questions in Chinese, but he has absolutely no knowledge of the language. I'll leave to your imagination whether the two strike up a real relationship and live happily ever after.

This is the Story of the Chinese Room. The setup is able to fool someone into believing there is a Chinese speaking person in the room, yet there is not. Where does the understanding of Chinese lie? The man definitely does not understand Chinese. And the book clearly does not understand Chinese because it is an inanimate object. Yet the person outside the room is convinced she is communicating with a Chinese speaker. The analogy to a computer is clear. The book is software and the man blindly following instructions is the hardware. John Searle, who devised the thought experiment uses it to show computers can never understand because there is no place in a mechanistic system for understanding to exist.

The Chinese Room has sparked huge argument in philosophical circles; let me boil it down to its simplest form. First, let's refute Searle's position with the 'System Argument'.

The man plus the book form a system. Systems understand; their individual components do not. My blood does not understand. My brain without blood would not understand – it would be dead! Plug my brain into a good supply of blood; add a dash of glucose, and it will understand the most complex of things.

The systems argument is elegant and most scientists think this is the definitive argument against Searle, but Searle has a neat way to counter it. "Imagine", he says, "that the man memorizes the book and leaves the room. Now there is no system, there is just the man, but the man still does not understand Chinese; he is just parroting rote-memorized words and rules." Computers, Searle argues, process syntax – the rules of language; humans understand semantics – the contextual meaning of language.

Artificial Intelligence (AI) proponents hate the Searle argument. They believe the memorization of a set of words and rules is exactly what gives us knowledge of Chinese. That is why we go to school!

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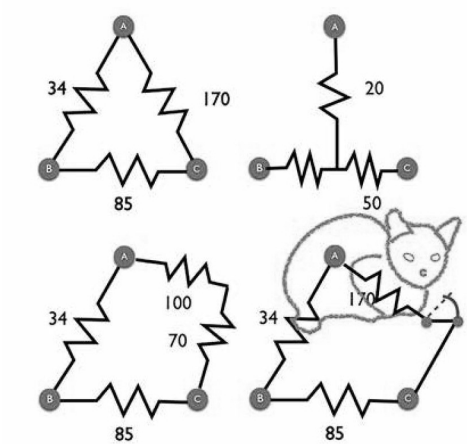
A key problem posed by Searle's Chinese Room is whether you can know everything about a situation from just looking at the inputs and outputs. This is very similar to the restriction posed by the Turing Test. In that case if we were to trace the wire from our computer terminal to the other room we would either find a human typing messages or a large box covered in flashing lights. This would definitively answer the question whether we were talking to a man or a machine. Similarly, if we opened the door to the Chinese Room we would immediately know whether there was a real Chinese speaker in there or not. But opening the door on both tests misses the point. The question asks, "if the inputs and outputs are the same does it matter what is *really* going on inside a closed system?"

Black Boxes

Experiments involving closed systems are known as Black Box experiments. They presume you can learn *everything* about the inner workings of a box simply by probing it from the outside. Young electronic engineers are often given black boxes as a test. Electronic components hidden in the box are connected to three external terminals on the outside. The student is asked to deduce what is in the box using only an electric meter to probe those terminals. Here are a few examples of the possible contents of a black box. They would all show up identically on the student's meter. Although internally different they are externally identical. Even my 'silly' fourth choice with a cat in the box does not give



Black Box Equivalence

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itself away if all you have to go on are electrical readings. (I dare say the cat would make its displeasure know if left in there for any time.) The contents are, therefore, said to be black box equivalent.

The reason for teaching engineers about black boxes is to help them understand how to simplify things. We could construct option four, with a cat and some food, but it would cost a great deal of money. Option 1 is functionally identical from an electrical point of view, but for a fraction of the cost. Steve Wozniak and Steve Jobs were so successful when they started Apple because Wozniak was brilliant at simplifying logic circuits. He could take a design with thirty chips and come back with a black box equivalent solution using only five. It was a fraction of the cost and far more reliable.

Scientists put great store in black box equivalence because of a principle called Occam's Razor. William of Occam was an English Franciscan friar living in the fourteenth century. He proposed the idea of minimal explanation. It states that, 'among competing hypotheses, the hypothesis with the fewest assumptions should be selected'. When trying to explain the workings of a black box, the more complicated inner workings should be discarded, as they have no externally verifiable effect over the simpler mechanism. Our extraneous animal must be eliminated! Sorry.

Ironically, given his calling, Occam's Razor is sometimes wheeled out as a disproof of the existence of God. Surely God is a complication unnecessary to the explanation of our Universe. The argument is illustrated beautifully in Carl Sagan's book *Contact* and the film of the same name. God gets the last laugh in Sagan's book when the difficulty with Occam's Razor is brought into sharp focus. Occam's Razor contains an inherent paradox. At any moment in time we only have evidence to support the simplest of explanations, yet we know many of these simple explanations are incomplete. We regularly discover new phenomenon – dark matter and dark energy being some recent examples. If we stopped discovering new things, Occam's Razor would be a good way to simplify our thoughts. Occam's Razor is a useful intellectual tool to prevent us over complicating explanations, but there will often be explanations that are correct, but for which there is not yet any observed effect.

If we go back to our black box example, we see the flaw in concluding the boxes are identical from examining only their inputs and outputs. Opening them would clearly show they are not identical! But, how would this fact reveal itself if they remain closed? The answer is: over time. If something in the box has memory or understanding, it could present one set of results for a while and a completely different set of results later.

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In my trivial example, the cat could eat a wire and change the operation of the black box. Now there is an open circuit where none existed before. If this happened, the output would change and we would need a new theory to explain it. If the circuit was attached to a missile control system or a life support system, you would really want a full understanding without waiting. It's humans nature to try to open black boxes. This is what MRI scans, X-rays, particle accelerators and all our other tools of scientific investigation are for. We want to open all the black boxes of nature and see what is going on inside: simply waiting to see what happens is not acceptable.

In a sense, we live in a black box. We experience the world through our senses, seeing with our eyes and feeling with our hands. The brain never directly experiences anything; it only infers the likelihood of

Scene from The Miracle Worker. Helen Keller pictured at the moment she understood language.

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something from the signals it receives. This is similar to our engineer probing the terminals of the circuit of a black box. How can we know our experience of the world is real?

Understanding the World

The French philosopher Descartes gave us an explanation for this paradox. He spent a long time looking skeptically at everything we perceive. For example, when we poke a stick into a pond, the surface of the water bends light and the stick appears to have a kink in it. Our eyes tell us the stick is bent, but our brain 'knows' the stick is straight: it's an illusion. Descartes wondered if something so simple could be an illusion, perhaps the whole of our experience is too.

His eventual solution underpins much of modern philosophy – 'I think therefore I am', *cogito ergo sum*. Even if we doubt everything else, we cannot doubt we are thinking about this doubt. At least we can rely upon the existence of this 'thought' as some reality. Descartes built up from this bedrock the real world we live in. We can be sure we experience things and can apply logic and use thought. We can use this intellectual faculty to tell a great deal about our Universe.

True Understanding

In the QED lecture series, *The Strange Thing about Light and Matter*, Richard Feynman relates the story of the ancient Mayan astronomers. 3000 years ago they were able to predict the motion of Venus in the sky using only pebbles. They had a simple system that could predict when the planet would rise over the horizon. Put a stone in the jar every day, take out a stone once a week, add a stone at every new moon. If the number of stones in the jar is divisible by 23, Venus will rise. I'm making up the details but you see the idea... It's a very simple algorithm. What should we conclude if the Mayans had perfected their calculations to predict the motion of Venus and it proved reliable over a whole century? Would this constitute understanding?

Feynman would say no: the Mayan understanding was not complete. It was only black box equivalent to our modern understanding over a limited period. We known that once the Sun begins to run out of fuel it will swell to a red giant and explode, destroying Venus and the Earth. Their model could not predict this catastrophic failure. Our modern deeper understanding of the workings of the solar system allows

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us to predict this future even though there is no clue from the motion of Venus today. Understanding allows us to predict discontinuous events: a system changing its state or a star running out of fuel.

We see the same predicament in stock markets. Stock markets normally behave in a linear fashion but, when they go wrong; they go *very* wrong. Recent recessions have been made much worse by the failure of hedging systems to handle market disruption. Some even think the crises were caused by the automatic trading strategies of these hedging systems.

The quants – as mathematicians in banks are called – spend considerable effort modeling financial instruments to show that if one stock goes down, another will go up at the same time. If the stocks are held together your investment is safe because, on average they will remain constant. The problem with these correlations, which often hold reliably for many years, is that when trouble hits they fall apart. Historical correlations don't give us understanding of the future: something that was only meant to happen once in a million years has happened within six months. As they say on your investment papers, past performance is no predictor of future results.

Do Computers Understand?

Today's computers don't have our general-purpose ability to understand. Watson was thrown off by badly formatted English. The human contestants, by contrast, had no problem with this. Just how good would Watson have to be, to call it – or should I say 'him' – intelligent? How could I judge this had happened? Alan Turing proposed an ingenious test in his 1950 paper Computing Machinery and Intelligence using 'The Imitation Game.' We now call the Turing Test.

If we ask a series of questions to a computer and we cannot tell its responses from those a human would give, then the computer is, for all practical purposes, the same as a human. Since we are intelligent – or at least we hope we are – the computer must also be intelligent. QED.

That's all there is to the Turing Test. Puzzled? Let's pick his argument apart.

Imagine you are chatting away on Facebook with someone you don't know. They may have posted a photograph so you can see what they look like. The photo might be a fake; you have no real way to tell. What question would you ask the other 'person' to prove they were human and not a computer? There are obviously some giveaway questions. Please multiply the numbers 342,321 and 23,294 and give me the answer. This

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would be very hard for a human but easy for a computer. If you got a very quick answer; the computer would have given itself away. But, the computer has been programmed not to give itself away, and it is free to give the answer slowly or even reply that the calculation is too hard. Our computer can say anything it likes, including lying to pass the test! If the computer can fool a questioner into believing it is a human then Turing argued the computer has shown it is at least as intelligent as we are.

It used to be assumed that the field of broad general knowledge would be hard for a computer, but Watson has shown this is not so. With enough storage and a reasonable algorithm, winning a pub quiz is well within the capability of a modern computer.

The really difficult questions for a computer are philosophical ones, novel questions and things that don't fall into a pattern. For example,

"Are you happy?"

"What do you think of Shakespeare's Hamlet?"

"Is there life after death?"

"How went it?"

"Think Differ..."

If a computer could plausibly answer this sort of questioning for an extended period, say fifteen minutes, should we conclude it is intelligent, or do we need more time to be certain?

Turing's approach to certainty was simple. Just ask lots of questions. As you ask more and more questions, you will become increasingly certain you are talking to an intelligent being. He characterized it as a linear process; after 15 minutes of questioning you might be 99% certain and after a few hours 99.9% certain and after a few days completely certain. The problem with this approach is it does not flush out discontinuities. What if the questioning suddenly stopped without warning or explanation? A human responder is likely to worry that the questioner has had a heart attack and do something to find out what is going on including leaving the room. Humans can make creative leaps, solve non-computable puzzles or come up with a clever new joke. A humans could even announce the test is a waste of time and walk off. They just exercised free will! A computer cannot do these things.

Each year a group of scientists enters a competition run by Cambridge University to win the Loebner prize, a competition to see how close a machine can come to passing the Turing Test. If you can beat the test you win $100,000. So far no one has come close and scientists are beginning to realize just how hard it is.

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"On the Internet, nobody knows you're a dog."

New Yorker Cartoon

With the anonymity the Internet provides we can imagine all sorts of strange scenarios if the Turing test could be passed. You would have no way of knowing what you were talking to. The New Yorker ran a cartoon back in 2000. "On the Internet no one knows you are a dog." We come across a similar problem the other way around when we encounter bad customer support. A few years ago, while trying to get an answer to a computer problem, I became convinced the thing responding to my emails was a machine. The company did use machine responder technology so it could well have been. I asked it to prove it was human by putting the word marmalade into an English sentence and fixing my

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problem. The human pretending to be a machine saw the joke, fixed my problem and replied "Marmalade is served with butter and toast." The test worked!

Uncannily not Human

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The sister test in robotics is equally hard. The goal is to simulate the physical human form, its movements and mannerisms. It's easy to get close, but close is not good enough. The term 'Uncanny Valley' has been coined to describe the discomfort humans have with something that tries to simulate a human being but does not quite get there. I think it is part of the reason Madam Tussaud's waxworks are so fascinating. Humans have a love-hate relationship with facsimiles of themselves. They love the flattery but feel a sense of revulsion at anything that comes too close.

Searle and Turing

In the Turing Test, we limited our senses to the purely symbolic: using only typed words on a screen. I could break the lock on the door and go into the room to see what was there.

"Aha!" I would say.

"I can see you're a computer, I, therefore, know you'll be good at sums and bad at creativity."

But Turing wants us to see if the difference is given away purely through intellect. He argues there is no way to tell. But if you follow my argument from chapter 1, there is one way: ask the computer to find a non-computable solution to a mathematical puzzle. This is, in practice, a difficult test to pose because it might take a *very* long time. Twenty-five billion people have lived on planet Earth during the last 350 years, and about 5 million of them were mathematicians. None of them was able to solve the problem posed by Pierre de Fermat until Andrew Wiles turned up but this is a clear difference between humans and computers. However long you give a computer it would never be able to solve the problem.

This creativity test would take centuries to run if non-computable thought was rare, but I think we see it often – on display even when we tell jokes. In which case computers and humans should be easy to tell apart: humans are the funny ones. I am not saying you can't build a brain; our brains are physical devices, after all. I just believe a computer or a mechanistic machine, cannot think like a human being.

I like the Searle argument but qualitative arguments are insufficient. We need a quantitative argument. In the forthcoming chapters, I am going to look at the mathematical argument underlying the difference between human intelligence and computer processing. Before we do this let's take one last look at a qualitative difference; the way computers and humans communicate.

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Chapter 3

BODY LANGUAGE & BANTER

Body Language

"England and America are two countries separated by a common language."

George Bernard Shaw

"I speak two languages, Body and English."

Mae West

"The body never lies."

Martha Graham

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In the summer of 1986 Ronald Reagan and Mikael Gorbachev met in person for their second negotiation session, this time at the Höfði House in Reykjavik. For five days, the leaders talked alone except for interpreters. Reagan badly wanted to develop the Strategic Defense Initiative; known by its nickname, 'Star Wars'. The idea was to put smart weaponry in space that could destroy ballistic missiles before they reentered the atmosphere. Reagan believed this would remove the threat of imminent destruction that had hung over the world since 1945. Gorbachev, on the other hand, felt this was just another escalation in the Cold War, and the Soviet Union would be forced to build yet more weapons to overcome the American defenses. He wanted Reagan's plans shelved, arguing that it broke the Anti-Ballistic Missile Treaty. He was probably right. The leaders talked back and forth, unable to overcome the impasse. At the end of the summit there was a mad scramble to announce some sort of deal, but this proved difficult. In the last moments before they had to conclude a communiqué, Reagan suggested they abolish *all* nuclear weapons. Reagan's negotiating team was horrified and shut the door.

For decades, the American strategy had been to use nuclear weapons as a deterrent against the apparent numerical advantage of the Soviets. In all the potential scenarios analyzed by the Pentagon, Russian forces ended up overrunning American forward positions – otherwise known as Western Europe! The only way to stop them was through a release of nuclear weapons, which, inevitably escalated to all-out nuclear

Ronald Reagan and Mikael Gorbachev

war. It was assumed this inevitable progression deterred the aggression in the first place, and the threat of mutually assured destruction kept the world peaceful. Giving up this tenet of defense strategy was something the American military just could not contemplate. Many people did not think it a rational defense strategy; it seemed appropriate the acronym for mutually assured destruction is MAD, but this was the status quo.

We now know our worry over Russian superiority was groundless. The West's technological advantage, founded on the invention of computing and sophisticated materials technology, gave us a huge advantage. In the only battle to be fought in the 20th century between Russian and Western tanks, during the first Iraq war, most of the Russian tanks were destroyed with no losses to American tanks. We know this now, but we are talking of a time when paranoia over the Soviet advantage was the common view.

There is speculation that Reagan had muddled intercontinental ballistic missiles with all nuclear weapons. I do not think this is true. Reagan was a man of vision, quite comfortable with using his folksy way to convey sincere belief, and I think abolishing all nuclear weapons was in his mind. It would have been a breathtaking moment.

In the end a rather feeble communiqué was put together and the talks declared a technical failure. But, both leaders had seen eye-to-eye; both were prepared to make major concessions and both wanted an end to the old strategy of mutually assured destruction. Wiping each other out was no longer considered a successful outcome! The meeting, and

Höfði House in Reykjavik

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the fundamental thawing of relations between East and West, was to lead to the Intermediate-Range Nuclear Forces Treaty and the end of the Cold War.

Face-to-Face Communication

What really happened between these two leaders when they met and talked? Was it a mechanical process of offer and counter-offer, as easily executed by fax, or is human interaction more complex than this?

Reagan, as a young man, had been a liberal, sympathetic to socialist ideals until a painful strike in California caused him to lose faith in the politics of the left. Gorbachev, a lifelong Communist, was desperate to reform the Soviet economy and make it more competitive. He, also, had come to see the hypocrisies that could emerge in far left-wing ideology. I don't believe this common experience could have been communicated by fax or email. Indeed, I am sure these specific points were never made, but the nonverbal communication must have conveyed something of their common background and purpose.

When we phone someone or exchange emails, the interaction is factual, there is no body language, and we rarely laugh. When we travel to meet someone, we spend a great deal of time with them. The average length of a phone call is two and a half minutes, but meetings, especially when one party has travelled to see the other, can be hours long. When humans meet they greet each other, shake hands, sit in the same room, talk at length, and laugh. Body language is important; people mirror each other's postures, adopt open and receptive stances, and make eye contact. You can see this in the picture of Reagan and Gorbachev above. Body language allows us to convey qualitatively different things, such as trust and happiness. It is very expressive; you can see the more guarded postures of Yasser Arafat and Shimon Pérez below, just after they negotiated a landmark peace deal. Can you tell if the leaders smiles are false?

Communication

Communication is one of mankind's greatest expenditures. The US telephone system is arguably the largest machine on the planet, while the world's mobile phone networks have a capital value of $2.5 trillion, greater by an order of magnitude than all the steel plants in the world put

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Yasser Arafat and Shimon Pérez

together. This lifeblood of our existence – long-distance communication between human beings – turns out to be amazingly difficult, even with all our clever technology.

In recent years the Internet has, in theory, allowed each and every person to communicate freely with any other person on the planet. In some of the most distant parts of the world mobile phones, and projects such as; 'One Laptop per Child' are rapidly bringing unlimited communication to all. This communication can be personal, one-to-one, or broadcast: I can talk to people interested in a particular topic directly. As we watch the Arab world democratize, catalyzed by the Internet, there is no question that digital communication has now become a major force in the world. Yet, people don't communicate over the Internet as much as you would expect; they often use the Internet to set up phone calls during which they arrange meetings! This is odd. We have a fantastic phone system and sophisticated communication technologies; email, video and instant messaging. Yet, we still choose to travel when we want to communicate.

On the face of it, there should be no difference between a phone call and a meeting. In principle the same information can be conveyed. Yet when we want to really understand someone, we always go to meet

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Smiles Fake or Real

in person. No great treaty or big industrial contract has been negotiated without a face-to-face meeting. We see this daily: people talking on the phone get to a certain point, give up, and arrange to meet in person.

The consequence is that we spend $550 billion annually, flying around the globe to meet each other. Each day the world's population takes three million plane flights. Around 80% of these are business flights. Some are people emigrating or going to do specific manual tasks, but most are to have meetings. We have always assumed that this is because the parties are unable to reach a sufficient level of trust over the phone and need face-to-face interaction to build that trust, but it may be that the parties are not able to convey sufficient information to fully understand each other. Face-to-face meeting may convey much more information than we think.

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Smiles

When we smile naturally we use a full set of facial muscles, including the muscles around our eyes. When the smile is forced those eye muscles remain passive and the smile, although superficially the same, is missing something. You can't put your finger on it, but the look is insincere. A study of marriages in the USA analyzed smiles in wedding photographs. The couples with false smiles divorced much earlier than the genuinely happy couples. Similarly for high school photos; people with genuine smiles at 18 years of age were happier later in life and in more stable relationships. Smiling is really important. It is good to be around people who smile, they are more successful – and nicer.

There is also a curious reverse effect. The link between our minds and bodies is much more fundamental than we thought. If you grasp a pencil between your teeth, it forces you to smile. Try it. The mere act of smiling is found to make you happier, it causes the release of the chemicals called endorphins which improve your feeling of well-being.

Micro-expression Analysis

Since the involuntary movements of the muscles around our eyes give away genuine happiness, a whole science has evolved looking for other biological cues to mood. The two most interested groups are the FBI, trying to detect lies, and poker players, trying to make money! Much has been written on the topic, including a few best sellers, but the evidence for micro expressions is mixed. Regardless of whether involuntary actions give away our emotions, humans voluntarily use a great deal of body language when talking.

Body Language

A study by Albert Mehrabian is often cited to say 93% of the information in a conversation comes through nonverbal cues. This is misquoted. The study really stated 93% of the *emotional* content is nonverbal. That's more believable. And further studies have shown when there is doubt, nonverbal cues win over verbal information every time. The rule is sometimes laid out as the 7%-38%-55% rule – 7% words, 38% tone of voice and 55% body language. Remember this is emotional content, your conviction and sincerity. You will still have to get over the factual information you want to convey.

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Learning Swedish with The Two Ronnies

Try this experiment on a friend. Tell them you like their shirt using different tones of voice: sarcastic, sincere, amazed. Then see what they understood. You will find it difficult to appear sincere because I have told you to say you like their shirt – unless of course you really do. When you use sarcasm they will find it hard to process your statement. It is revealing how we use the information.

Interestingly, a piece of research described in *Scientific American* shows even insincere flattery is effective. If you want a pay rise from your boss, any form of flattery will do. Vanity appears to override skepticism!

Interaction

The normal cadence of communication between people includes a great deal of mutual interruption. When a meeting breaks down we often see people begin to say things like, "Please don't interrupt me," "Do you mind, I was talking," "Pleeeease, let me finish." If the meeting is really getting out of hand, third parties will often step in and tell one to wait for the other. This is where the mechanics of face-to-face interaction fail, as we need to interact in order to communicate effectively.

Because we have a lot more time in a face-to-face meeting people can wander 'off topic'. This is an important part of the process of communicating. After all since most phone calls are 2-3 minutes and

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most meetings an hour, there are another 57 minutes to fill! These off topic items bring in social experience and help us form the background context we need to properly communicate.

What is Background Context?

Alex and Bella are both fans of the British comedy duo, the Two Ronnies, and enjoy their learning Swedish sketch. Bella asks Alex what kind of sandwich he wants for lunch. Alex replies 'M'. Bella laughs. If you have seen the sketch you will understand the background context to the joke. If not this paragraph might as well have been in Swedish. Take a look at the sketch on YouTube and reread this paragraph... Now you understand.

Do I think in English?

Most scientists believe we think thoughts using language, but most scientists writing about thought are linguists or psychologists. If you are a dyslexic engineer like me, language is a long way down the processing chain. I think abstractly and then translate those thoughts into words. Some ideas don't map between languages and often, one language adopts the words of another to fill in the gaps. Some interesting examples are:

Zeitgeist	German, spirit of the times
Schadenfreude	German, enjoying others misfortune
Chutzpah	Hebrew, audacity

All of these are fully signed up, card carrying entries in the Oxford English Dictionary.

Some languages have fewer distinctions between ideas: truth and law are the same word, 'torah', in Hebrew. Languages have different tenses and structure. In Chinese all words are one syllable and the script is pictographic rather than phonetic. This is unusual, even Egyptian and linear-B, which look pictographic are mostly phonetic. With single syllable words, Chinese uses voice inflection to change meaning; a rising or falling tone can change the meaning of a word from 'grey' to 'girl'. In many Western languages rising voice inflection is used to indicate a question, as in Australian English or irritation, as in English English. So how do the Chinese show if they are annoyed or want to ask a question? They elongate their words and accentuate the changes in intonation. An argument in Chinese can sound quite alarming to the Western ear, with its percussive monosyllables and extreme inflection changes. This

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degree of inflection is used in English, but only in extreme emotional contexts: A Chinese argument over cold tea can sound like an accusation of murder to a Western ear.

Symbolic Communication

The earliest recorded permanent human communication is cave painting, dating to 33,000BCE. Written communication emerged in Sumer, the southern part of Mesopotamia (now Iraq), using a script called Cuneiform, written on clay tablets. It was used primarily for accounting. The Sumerians are responsible for our common use of base twelve. Twelve hours in a day, inches in a foot, and notes in the scale; all stem from their civilization.

Although not the first to write stories, the Greeks perfected the dramatic forms we use today: poetry, prose and plays. Watch an episode of 'Law and Order' and you are seeing a direct descendant of a Greek tragedy, complete with suffering and justice denied. All this permanent *thought art* is made possible by the translation of ideas into symbols.

Scripts and Symbols

The world supports a huge variety of scripts split roughly into phonetic, representing the component sound of words, and pictographic, stylized pictures of the ideas.

Chinese Traditional and Simplified

Some scripts have interesting quirks. Ancient Hebrew, although phonetic, is a script where vowels are omitted. Modern Hebrew often leaves them out as well. This means words can be ambiguous and need context to decipher them. A common set of Chinese characters has long been used by Mandarin, Cantonese, and Japanese speakers even though

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their spoken languages are entirely different. The script languages of these people are gradually diverging and might in time become entirely separate languages too.

The Chinese government in Beijing has moved to using simplified Chinese for Mandarin speakers, while Hong Kong continues with the traditional form. Japanese has developed many new characters for

Latin	Hello Reader
Japanese	読者こんにちは
Russian	Здравствуй читатель
Greek	Γεια σας αναγνώστη
Hebrew	שלום קורא
Arabic	مرحبا قارئ
Chinese	讀者：您好！
Chinese	读者：您好！ *simplified*
Korean	리더 인사
Japanese	読者こんにちは
Linear-a	can't be translated!
Linear-b	(best I could do is 'new wine')
Lao	ສະບາຍດີຜູ້ອ່ານ
Hindi	पाठक (hello)
Persian	سلام خواننده
Hieroglyphics	

modern ideas, such as computers, that differ from the Chinese, and mixes in a great deal of Katakana, a script allowing the phonetic representation of foreign words. If you walk around these countries their signage looks quite different, although I am told Cantonese speakers can still read

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simplified Chinese. Take a look and normally you will find them to be quite different. Each example in the figure is my best attempt to translate the phrase "Hello Reader" into a script and the corresponding language.

Symbols of the World

English is one of the most irritating script languages of all. It commonly uses etymological elements, showing the history or origin of the word that has nothing to do with the sound of the word. A word like school has the 'k' sound spelt 'ch', showing its historical derivation from the Greek, but confusing for pronunciation. English has 53 sounds derived from only 26 letters, so there are plenty of letter combinations, many of which are irregular. Because the language favors historical convention over simplicity, sugar is pronounced "shu-gar" whereas sand is strictly phonetic. As for Leicestershire I'll leave that as a test for the American readers amongst you. If you're British, try Mattapoisett, a town in Massachusetts named in Native American.

Yet English is also a 'lovely' language. Because of its richness there are often twenty different ways to say something, and a dozen words to choose on any topic. One of my own favorite words is 'jump'. It is phonetic, but also onomatopoeic and even pictographic. Jump both sounds like a jump and looks like a *jump*.

Two scripts that puzzled scholars for many years are Linear-b and Hieroglyphics. Linear-b – found on clay tablets on the Island of Crete – turned out to be a coded form of ancient Greek with some slight quirks, such as dropping the letter 's' from the ends of words. The 's' is superfluous in most Greek words, and dropping it saved precious clay space!

Hieroglyphics was a real puzzle. It looks so like a pictographic language that it fooled many people for centuries. The Rosetta Stone was discovered in 1799 and became the key to their deciphering. This stone had the same edict written out in 3 languages – Greek, Egyptian and Demotic. The French adventurer Jean-François Champollion decoded hieroglyphics in 1822 and although it *looks* pictographic, it was found to be predominantly phonetic. Linear-a, another script found on the Island of Crete has yet to be decoded and remains one of the world's great-unsolved mysteries.

All these different ways to code ideas into symbols present the children of the world a great learning challenge. Because written language is so young, in evolutionary terms, our brains have not had enough time to evolve to master it. Instead words co-opt parts of our brains originally

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evolved for different purposes. As languages differ in their construction they co-opt different bits of the brain. It is possible to see this using brain imaging.

Dyslexics – and I am one – have difficulty in translating between the realm of conceptual thought and written script. This translation is subtly different for each language. Chinese speakers use their motor cortex to process characters. Young children write out the characters over and over, to memorize them, so the 'muscle' memory is highly involved. French and Spanish children use the audio pathways, as most of their language is phonetic, the motor part of writing is then an add-on and does not process meaning. English children must use portions of their visual cortex to process the meaning of words, as many words have spelling quirks that have nothing to do with the sound of the words. Some studies even suggest a child dyslexic in one language, because, for example, their audio pathway is impaired, might not suffer the condition in another language that relied on a visual or motor skill.

Can Objects Communicate?

The process of communication has many components, starting with something capable of communicating. Communication usually – perhaps always – is something that occurs between sentient beings. I don't think of my computer as communicating with me, but rather think of it as a medium for communication or a dumb machine. But colloquial language around the subject is a little muddled. We all agree a lighthouse does not communicate, even though it can signal danger, but what do we mean when we say, "That song really spoke to me." No one believes the song is actually communicating, but some kind of communication was made nonetheless. When we talk of communication do we mean the agent or the message?

Stories

Humans enjoy communicating; we create works of art, music and literature that transcend simple analysis. The COIN dynamic slide, which we saw earlier detailing the strategic situation in Afghanistan, would probably have been better communicated with a story. Humans, unlike computers, do not cope well with large quantities of unrelated information, and studies of memory and comprehension show we

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benefit from a narrative structure. Let me give you a basic example. One simple trick the human brain uses is chunking. Give yourself a moment to try to learn this string of characters.

HALTNTIBMGTATLAMATLOLPOMSGTG

TRY TO MEMORIZE THE STRING WITHOUT READING ON

Now, if I divide it into chunks, you will see it includes meaningful information.

HAL TNT IBM GTA TLA MAT LOL POMS GTG

You probably won't recognize all the acronyms unless you are under 10. Even then, you will find memorizing it hard, but if you put the sequence into the context of a story then it is much easier to learn.

HAL uses TNT to blow up the IBM building in Grand Theft Auto. "Three Letter Acronyms are annoying," says MAT. I'm Laughing Out Loud; Parents Over My Shoulder. Got To Go.

We find it easier to fit new information into existing structures within our brains rather than memorizing by rote. I've used quite a bit of modern Internet slang here. You'll find young people recall this information better than older people for whom GTG and POMS are nonsense.

If you want to memorize something, experts recommend you imagine bizarre images and relate them to a story pictured in the mind's eye. Try it and you may very well find you can still remember my sentence in ten years time!

Let's try something else. The following sentences are a little different, yet the recall scores for information in the two are dramatically different:

1. I met an old tramp on 42nd Street wearing a dirty grey rain coat.

2. New York on a cold damp November day; as I cross the street I bump into an old man wearing a dirty grey Macintosh. His shuffling gait suggests some sordid intent. I think nothing of it, but this brief meeting was to change my life.

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The addition of contextual cues allows you to form a mental picture. By withholding some information at the end I have used a dramatic trick to cause your brain to free wheel and imagine what happens next. You are involved in the story. Notice the *longer* story, with more data in it, is paradoxically more comprehensible and memorable.

Ed Tufte makes the point about our ability to process information very forcefully. He believes presentation experts are wrong when they recommend you keep your slides to a few words! He points out the common advice to use only six bullets per slide and six words per bullet comes from a misconception that has blighted a generation of presenters. Studies performed on memory in the 1960s measured unrelated word recall. Six words are all you can remember if the words are meaningless. But if the words have meaning we can comprehend and absorb many pages of data. Hundreds of millions of people throughout the world read a newspaper every morning and can recall the stories throughout the day; the poems, songs and plays we memorize when young are usually long, comprising thousands of words, yet we are able to remember them verbatim for the rest of our lives.

When we tell a story, we are trying to draw the reader in so they can to experience our imaginary world and be 'in' the story. When I read a story – perhaps *Harry Potter* – I don't think about the grammar and punctuation, or even the accuracy of character portrayal. I'm transported to a different place. I experience a piece of the reality or 'imaginality' the storyteller has created. I can describe the characters, the scene, the sounds and the smells. A good author forms a complete world in our heads corresponding with the world they have in their heads. With more abstract information, comprehension and retention is harder. Often if the information does not hang together in a linear narrative it can be impossible to take in at a single sitting. However, if it forms a story and is well told so you 'get it', you do not need it repeated. We experience something of this effect when we watch a good movie. "I've already seen that one," means you have absorbed the whole story in a single sitting. You don't need to watch it over again to comprehend it.

Comedy

Finally, when you mix all the elements up, emotional understanding, body language, in-person communication and empathy; you get comedy. Humans 'do' comedy from a very young age and it's vitally important to the fabric of our lives. What purpose comedy serves in communication

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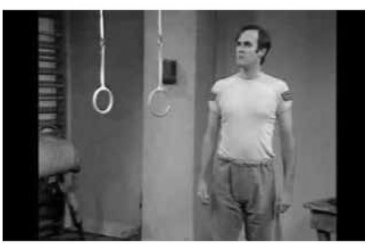
My XBox is Broken
The One Ronnie

Dead Parrot Sketch
Monty Python

Gerald the Gorilla
Not the 9 O'Clock News

Fork Handles
The Two Ronnies

Andre Previn
Morecambe and Wise



Self Defense Against Fruit
Monty Python

is not clear. In life, telling a joke will make another person smile. This causes people to be happy and happy people release chemicals into their bloodstream which make them healthier. Happy people then tell jokes to others. This circular process improves the well-being of communities and helps bond people together. But why on Earth did comedy evolve to be the mechanism that does this?

Comedy may be an important way to avoid an argument when context is unclear. Much of what we say can be taken the wrong way. Simple communication of fact can sound like criticism or challenge, and

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humans are naturally hierarchical – not unlike packs of dogs or beached walruses. Humor allows us to test the response of others to statements, which might otherwise be taken the wrong way. Something said in a 'jokey' tone of voice may not generate a negative response, even though the raw content might be quite provocative. "Ah, late again I see…"

It is worth taking a look at some great comedy sketches because they bring home the richness of human interaction. Here are some of my favorite links as an antidote to the heavy-duty mathematics I am about to inflict on you.

The World's Funniest Joke

> *Two hunters are out in the woods when one of them collapses. He doesn't seem to be breathing and his eyes are glazed. The other guy whips out his phone and calls the emergency services. He gasps, "My friend is dead! What can I do?" The operator says, "Calm down. I can help. First, let's make sure he's dead." There is a silence, then a gunshot is heard. Back on the phone, the guy says, "OK, now what?"*
>
> Spike Milligan, from *The Goon Show*

I think comedy is a fitness display. It demonstrates to those around us – particularly of the opposite sex – that we can be creative and use non- computable thought processes, just as dancing is a fitness display of our agility and coordination. When we tell a joke we are showing others we can 'think outside the box', a valuable survival skill.

At a simple level it has been proven that animals with the ability to behave randomly escape being eaten more often than animals that follow a pattern. Non-computability is the ultimate behavioral randomizer since it is not an algorithm and cannot be copied. The ability to take non-computable thinking to its logical conclusion to create and invent has clearly taken off for humans.

Of course, another explanation might be that making people happy is fun. People like to be around other fun people so humor encourages crowds to form. If a saber-toothed tiger attacks you, and you are in a crowd, you're more likely to survive. You only have to outrun one member of the crowd!

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Chapter 4

THE BRAIN

Baby EEG

"The brain is a wonderful organ; it starts working the moment you get up in the morning and does not stop until you get into the office."

Robert Frost

"The brain looks like nothing more than a bowl of cold porridge."

Alan Turing

Physically the human brain is very boring. Alan Turing described it as looking like a bowl of cold porridge. To get to the porridge you must first cut through the skull, a two-millimeter thick protective layer of bone. The adult human skull has almost no gaps in it, and the only ways into the brain without a bone saw are through the eye sockets or the soft area of bone at the back of the nose. Egyptian mummies had their brains removed through the nose and preserved in a jar for the afterlife!

Thinking with Porridge

Protecting the brain is very important and the skull does a good job by being a tough, impenetrable barrier. But sometimes this toughness backfires. In 2009, Richard Hammond, one of the presenters of the TV motoring series Top Gear, suffered a crash while testing a land speed record-breaking car. Although he was in a multipoint harness, the crash, at over 200 miles per hour, bounced his helmeted head around the inside of the cockpit and his brain was badly bruised. As you know from experience, when you bruise you get swelling, and the brain is no exception. However, the brain is encased in bone, so this swelling has nowhere to escape. The resulting buildup of pressure is dangerous, causing an interruption of blood supply to the un-bruised parts. Brain damage in such accidents is often fatal; Richard Hammond was very lucky to live through the experience.

Surgeons often need to cut into the skull to relieve pressure on the brain, or to gain access to remove tumors. Going through the scalp involves a great deal of blood, but once you have a clean hole in the skull you can peel back the thin membranes, called the meninges, to reveal a wrinkly folded whitish thing that looks a bit like a cauliflower. This is the outer surface of the brain where much of our thinking is done. Unfolded, this surface layer would cover the area of a football field and this intense folding distinguishes the human brain from the brains of simpler animals. Some animals, such as elephants and dolphins, have larger brains than ours, but the area of their folded surface is considerably smaller. It is thought that this efficient folding is key to giving us the ability to think complex thoughts.

Analysis of Einstein's brain held at Princeton University shows it is not particularly massive, but it is strikingly more folded than average, and has a shorter lateral sulcus – the fissure between the front and back

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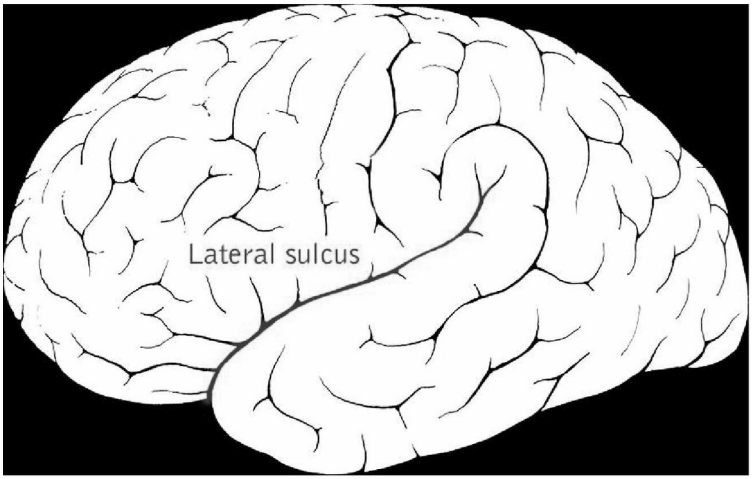

Einstein's Brain

of the brain. Whether this is related to his highly creative thinking or just random chance is unknown, but it's an interesting data point in our quest to understand creativity and intelligence.

Looking through a microscope, the wrinkly grey matter is composed of 30 trillion neurons; small whitish cells sprouting filaments that wrap around each other like the tentacles of an octopus. The tentacles, and there can be as many as 10,000 per cell, are known as dendrites and spread out to nearly touch other neurons. At the other end of the neuron is a single axon. The gaps between the end of an axon and the next neuron's dendrites are called synapses, about one-tenth of the width of a human hair and varied in structure. When a nerve 'fires', an electrical pulse spreads out along the axon to the end and crosses the synapses to other brain cells. This electrical pulse is not like the flow of current in a wire: neurons don't conduct electricity. It is more akin to dominoes falling in a line. Ion gates in the walls of the neuron open, letting potassium ions flow out. As the gates open in one section, the next section is triggered and so on. Thus, electrical signals ripple out along the axon. As the electrical signals cross the synapses they either excite or inhibit the firing of adjacent neurons. There is a lot more structure to a neuron than was once thought. The textbook model is of a sequence of ion sacks stacked end to end rather like plant cells, but neurons have a far more complex structure. Bundles of actin and tubulin form a skeleton in the neuron and the neuron metabolizes ATP to recharge its firing mechanism. Neurons behave far more like small animals than inanimate plant cells.

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The wiring of our brain looks a bit like the logic circuits of a computer, and our best guess is the cells in our brain form some kind of computer. The brain cells – a specialized form of nerve cell – connect to the rest of the body via the nerve cells that largely run down our spine. Thoughts trigger action and, in reverse, the nerves in our extremities sense things in the environment and relay information back to the brain. If I think, 'move my finger' my finger will move, and if it touches something I will feel the sensation. Interestingly if my finger touches something hot a reflex will kick in. Reflexes work without involving the brain. We don't have to think, "that hurts." Instead, our finger reflexively pulls away. We may say ouch, but by the time we do, our fingers already moved away from the heat.

Nerve cells are much slower than the electronic systems we build with copper and silicon. This speed is quite noticeable and limits the rate we can do certain things. It takes around 0.08 seconds for a nerve impulse to run down to the tips of our fingers, initiate an action and return to give us the sensation of the action. This may sound fast but if you're a tennis player in a rally or a pianist faced with a fast passage, the nerves don't have time to make a full round trip signal before the next action must be initiated. In these instances we need to run on autopilot and there are parts of the body where the nervous system takes action without the brain getting involved. This is particularly the case with things like walking and balance, which must respond fast to changes in ground conditions. The signals just don't have time – and don't need – to go all the way up to the top of the body for instructions. Rather like the heat reflex above, the peripheral nervous system can process information locally. After all, brain cells and nerve cells are really all one type of cell.

If you have a group of people, you can conduct a fun experiment to show the speed of nerves. Hold hands in a big circle and squeeze the hand of the person next to you. When they feel you squeeze, they should squeeze the next person's hand and so on. The rate at which people squeeze hands around the circle is limited by the speed at which nerves conduct the signals across our bodies.

Imaging the Brain

There are several ways to look inside the brain without recourse to a bone saw. The methods are fascinating in their own right, even before we start looking at the results. Each image is generated using a different physical principle.

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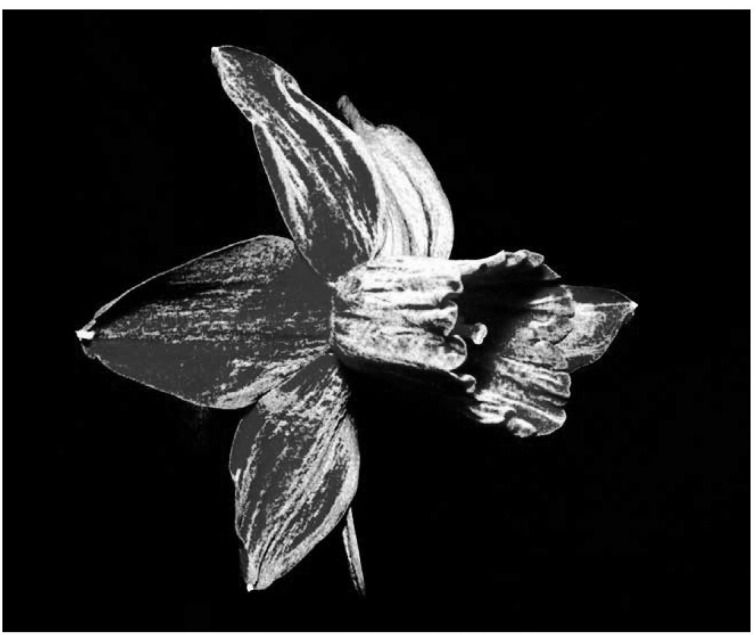
X-rays

The first Nobel Prize in Physics was awarded to Wilhelm Röntgen in 1901. He had discovered 'X' rays; so called because he had no better name for them. X-rays, as they became known, are just light of a very high frequency.

Light comes in a variety of colors; at the low end of the frequency scale we see red, higher up blue and, at the top, violet. At this point human eyes give up and cannot see anything higher, so ultraviolet light is invisible to us. Bees, on the other hand, can see a long way into the ultraviolet spectrum and some flowers have beautiful ultraviolet markings that attract bees for pollination. Daylight contains a great deal of ultraviolet light which is wasted on us – other than to tan our skin. But all is not lost. Clever manufacturers put fluorescent dyes into their washing powders which stick to our clothes and convert ultraviolet into visible light, making our T-shirts look brighter as they reflect *more* visible light than fell on them. You can see this effect most easily in a disco when ultraviolet lights are shone on the dance floor and anyone wearing a newly washed T-shirt will glow bright white. The other common substance that fluoresces strongly on a dance floor is tonic water. Quinine, the active ingredient in tonic water, is a strongly



Flowers in Ultraviolet Light

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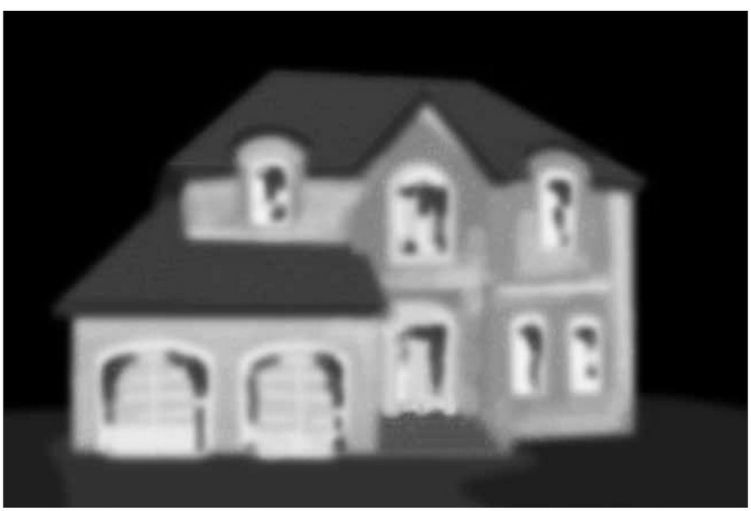
Pit Viper

fluorescent substance which converts ultraviolet light down into the visible spectrum. Photoactive dyes have recently become controversial as suggestions have been made that they are unsafe and irritate the skin. Going to discos might not be quite as fun in the future!



Thermal Imaging

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At the bottom end of the spectrum is infrared light. Pit vipers have evolved special organs on the sides of their heads to 'see' in this spectrum and they use this sense to hunt prey in the dark. I use the word *see* with some caution. We have no idea what their sensation of 'heat-sight' involves, but their organs are very precise, able to detect things only 0.2 degrees warmer than the background.

Infrared cues help several species of snakes, bats and insects locate things in the dark, but the animal that excels at the task, albeit using technology, is mankind. Special cameras allow us to use infrared to see in the dark or detect where our houses lose heat.

X-rays are much higher in frequency – about one hundred times that of the ultraviolet light that affects our T-shirts. The high frequency corresponds to a small wavelength that allows the rays to pass through our bodies. Later on in the book we will understand that frequency is not a proper explanation for light, as it is not a wave but rather a particle that obeys the laws of a wave. But for now we will ignore this detail.

The first use of X-ray images was to see broken bones. Bones block the rays as they are dense, but the soft parts of our bodies are almost completely transparent to X-rays. We can see the soft tissues if we turn the contrast up, but there are problems when using X-rays to view the brain. Our skull completely encases the brain and however much we turn the contrast up, all we see is bone. The solution to this problem is to perform sophisticated mathematical tricks using a computer to enhance the contrast ratio and make image 'slices' through the living head.

The slicing technique was invented independently in the 1970s by Sir Godfrey Hounsfield, working for EMI in England, and Allan Cormack, of Tufts University in America, and they shared the 1979 Nobel Prize for Medicine for their work. Legend has it that EMI was making so much money from The Beatles they could fund the enormous development cost of the CAT scanner from the profits; true or not, it's a great invention.

The best way to understand the mathematics is to picture yourself in an episode of 'CSI', the American television crime drama. An intruder has attacked someone with a knife and there are blood spatters all over the walls of the room. Enter the brilliant pathologist who reconstructs the scene of the crime from the pattern of blood on the wall. She can map the trajectory of the blood spatters and back-calculate that the attacker must have been 5' 4", left-handed and wielding a 6" blade. In a CAT scan, our head is hit with billions of rays that bounce and scatter over the walls of the machine. Sensors detect the rays and a mathematical algorithm calculates an image of the body that would produce such a pattern. To

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X-ray of Roentgen's Wife's Hand

simplify things we shine the X-rays onto the head as a narrow slit of light so we only have to do the back calculation in two dimensions. Then we stitch successive slices together in the computer to form a 3D virtual image. Thus, doctors can 'fly' through the brain looking at structures such as tumors from all angles.

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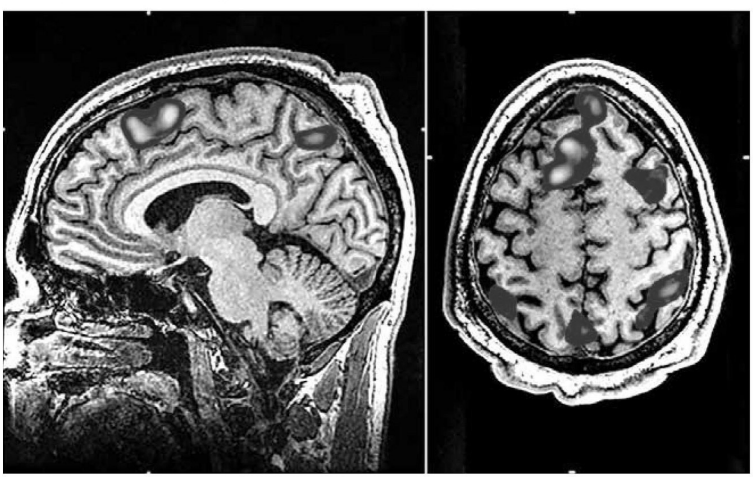
There are two problems with X-ray imaging. Even with clever mathematics, the dense bone in the skull blocks the rays so you don't get much contrast, making it hard to distinguish normal brain matter from something like a tumor. But the bigger concern is X-rays are a form of ionizing radiation, and ionizing radiation causes cancer.

We are told to wear sun block to protect our skin from ultraviolet light; X-rays are 100 times more potent and can do a great deal of damage. Fortunately, the body repairs itself quite well in the presence of low levels of radiation. The *double* part of the double helix in our DNA allows a set of proteins in our cells to go around correcting errors when they detect a mismatch between the two strands. But, now and again an X-ray might make an irreparable fault in both copies. If enough of these faults accumulate, they can lead to cancer or, if the errors are in reproductive organs, birth defects. Doctors try to minimize the radiation we receive and give us as few CAT scans as possible during our lifetime, especially when we are young and have not yet had children.

MRI

X-rays dominated our ability to see into the human body until the mid-1970s when Raymond Damadian came up with the idea of using magnetism. Magnetic fields are not absorbed by bone and present no danger as they do not damage DNA. Ironically, the technique was originally known as Nuclear Magnetic Resonance, 'NMR', which patients thought must be dangerous because of the word nuclear. The name was



Functional MRI: Working Memory

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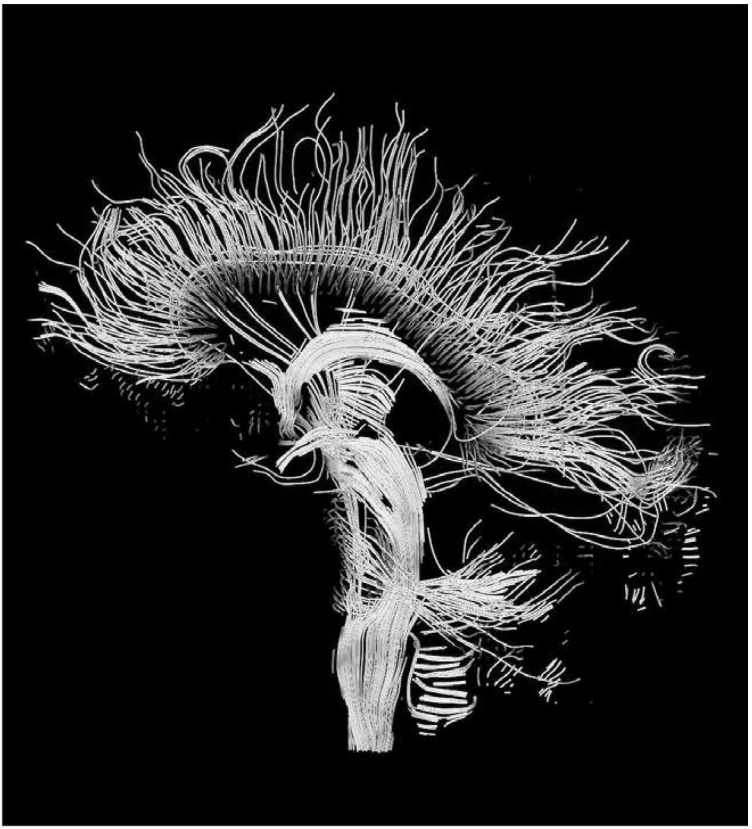

Diffusion Tensor Image

changed to the one we use today: Magnetic Resonance Imaging, 'MRI'. The system works by applying a strong magnetic field to your body to excite the hydrogen atoms. Since we are mostly H2O there are plenty of these.

Three magnetic fields are used. First, an extremely strong field is applied to the whole body. This causes all the hydrogen atoms in the water and fat to spin in line with the field of the machine. Next a gradient field is applied to the top of your head so it is slightly more magnetized than the bottom of your feet and, finally, a pulse of magnetism is applied to the top of your head. The spinning hydrogen atoms line up a little more when this pulse is applied and then randomize again when it is switched off. As they randomize, they give off energy. The clever part is the gradient field which causes the atoms to give off energy at slightly different times – the top of your head first, your neck a fraction of a

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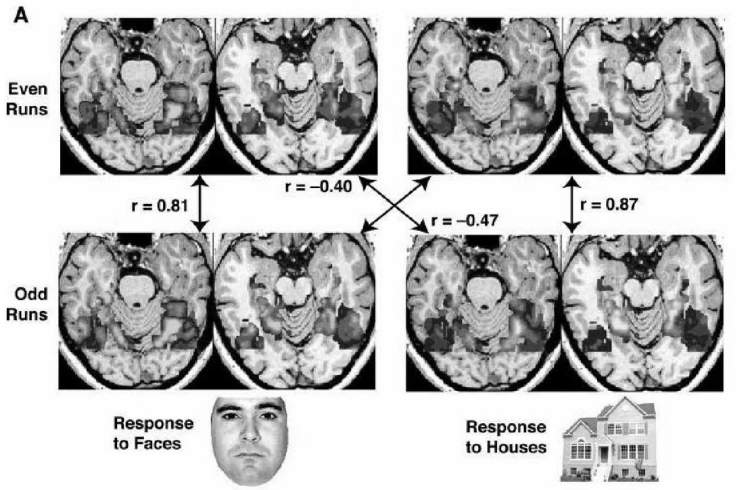

fMRI

second later, and so on down to your feet. What you see at any one time is a slice through a specific section of the body. You can then build up 3D images from these slices and look at the soft watery tissue rather than the hard bone you can see with an X-ray.

MRI scans give detailed images but today there are many more imaging tricks you can play. Give the patient gadolinium to eat – a type of paramagnetic material – and this contrast agent will highlight active parts of the brain. You can 'see' which parts are active: the location of emotions such as love, joy and even the effect of smells as the brain experiences things. This is still coarse grained information; it shows only the general area of excitation and it does not tell us what is going on at the nerve level, but the images are fascinating.

Another recent development in imaging is the diffusion MRI. If you remember your school physics, molecules travel with a random walk: they diffuse along pathways just as people wander along a corridor. If the corridor is full of people, they are jostled around and make little progress. If the corridor is empty, they move in straight lines. This difference in jostling affects the reading in an MRI and allows you to color code the image according to the rate of motion of water along the pathways. You can therefore 'see' the rate at which signals flow in the brain and not only locate thoughts, but also see the links between them.

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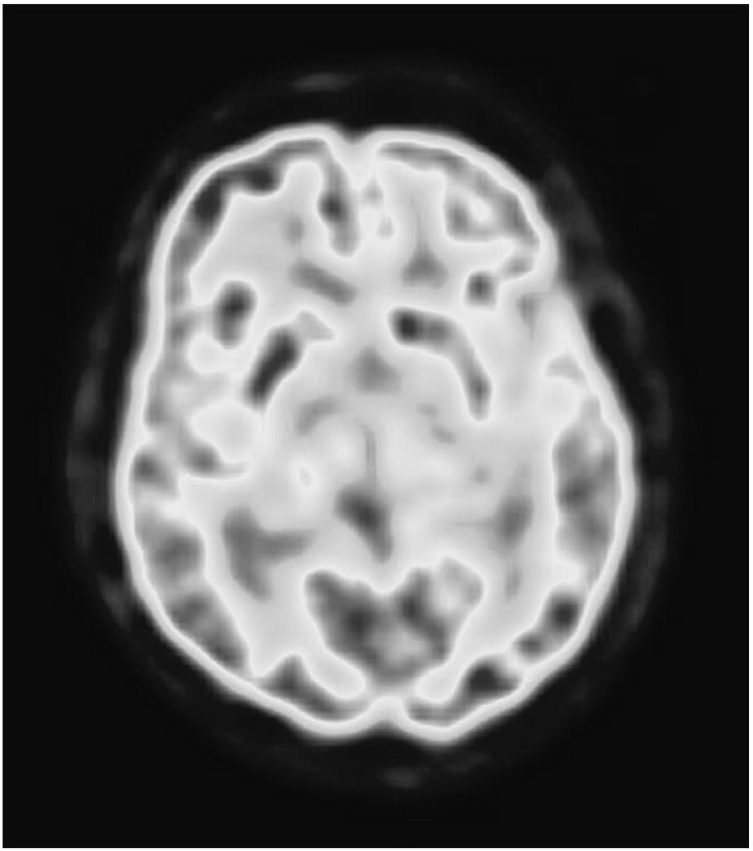

Functional PET

PET

The last scan we will look at is functional positron emission tomography, or f-PET. In this machine the scanner detects positrons given off by excited oxygen atoms.

As you think, you burn glucose by combining it with oxygen. The parts of the brain that are thinking hard use a great deal of oxygen and this shows up in scans. Again the consecutive slice trick is used to generate a 3D image that allows you to fly through the brain as it works on a problem.

There is one problem common to all these methods. X-rays, MRI and PET scans only show us the location of thoughts with an accuracy of a few millimeters. Each pixel in the image contains around 10 million neurons, so we can't see the details of thought. For a scale comparison it

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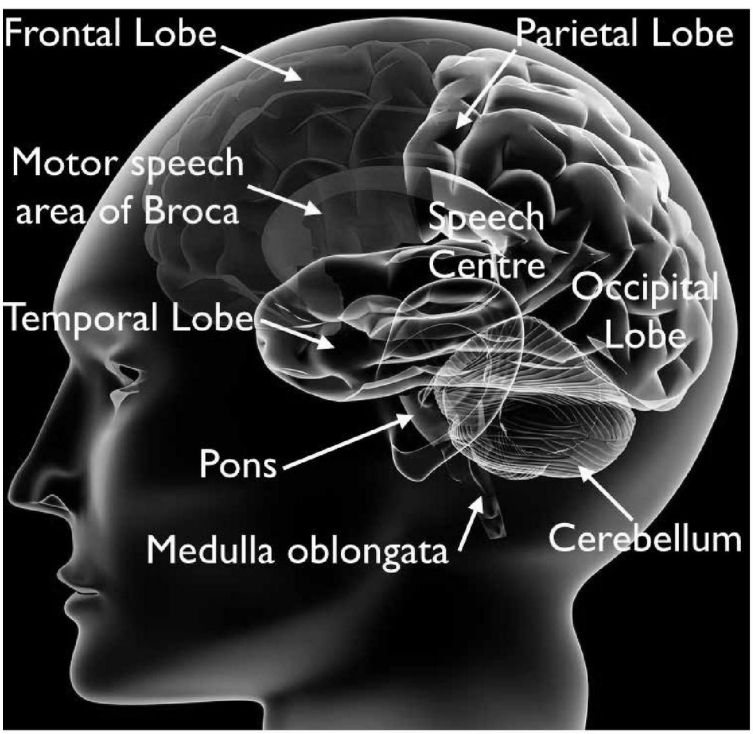
is like looking at a car factory from space. You can see cars and people going into the factory but you can't read the owner's manual. We need to be able to see at least 10 million times more detail than our current technologies allow to *see a thought*.

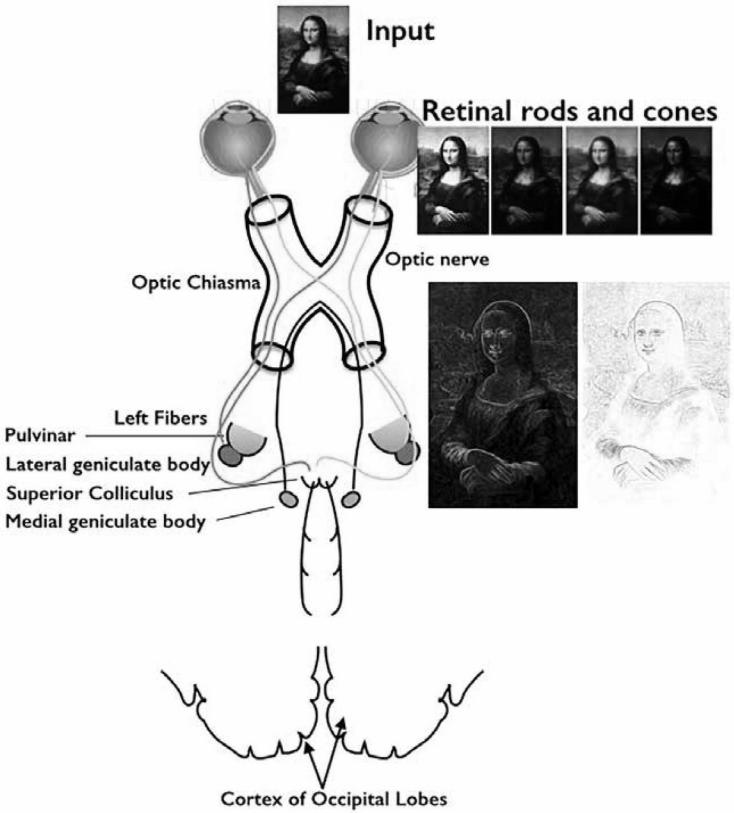
A Quick Tour

Now that we understand how to look inside the brain, let's take a tour around it. The brain is a highly distributed thinking machine. Some things, such as hearing, are located in specific places while others, like the enjoyment of music, are spread out.

Our eyes work as an extension of the brain and use a specialized type of nerve cell. Light falls on the retina and stimulates these cells, causing nerve impulses to run along the optic nerve into the center of the



The Brain



Visual Processing System

brain. The impulses split and form two distinct paths, one through the cerebral cortex, which gives us the sensation of conscious vision, and the other into the lower brain which provides us with instinctive reactions.

The right hand side of your body is connected to the left hemisphere of the brain and vice versa. This means each hand is controlled by the opposite side of the brain. But, your eyes see both your hands. To resolve this conundrum a very complex thing has to happen to the optic nerve in the center of the brain. The optic nerve from each eye splits and crosses over in the middle, so the left side of the left eye and the left side of the right eye goes to the right hand side of the brain and vice versa. This keeps the brain focused on the correct hand.

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Frogs Eyes are Very Sensitive

The processing power of the eye is staggering. The human retina has about 120 million rods and 7 million cones, giving it an average resolution of 10,000 by 10,000 pixels. Each rod is sensitive to individual photons but we register light consciously only if we see around 5-7 photons. It is thought frogs can react to single photons because of the chemistry of their eyes and the fact they are cold-blooded, but this is not proven.

Some animals, including some frogs and my cat, have a tapetum lucidum. This is a reflective backing to the eye that allows each photon two chances to react with a rod, once on the way in and, if that fails, once on the way out. This is why you can see the eyes of some animals if you shine a light into the forest on a dark night. Cones are less sensitive than rods but give us color perception. In the human eye, there are three types of cone: a red, a green and a blue, giving us trichromatic vision. We see colors because light stimulates more than one types of cell and we infer the color in between. A fourth type of cone is present in some species such as birds, reptiles, and fish. This gives them tetra-chromic vision, allowing them to see into the ultraviolet range. It is speculated some humans might have this ability but so far none has come forward. Some animals lack the ability to see certain colors. Most dogs can't see red. This gives cats a big advantage!

Many people wonder if we all see the same color as each other. Is your red the same as mine? The brain's perception of color is complex. Although the color red is absolute and can be detected by a calibrated sensor, our perception of color is relative. We perceive them in the context

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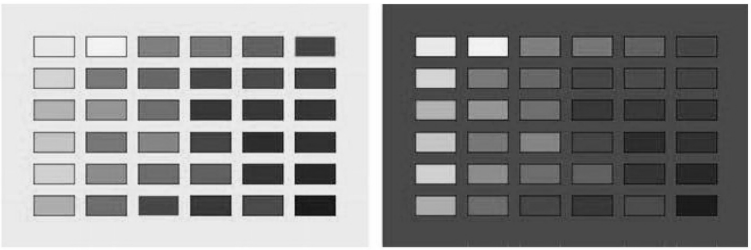
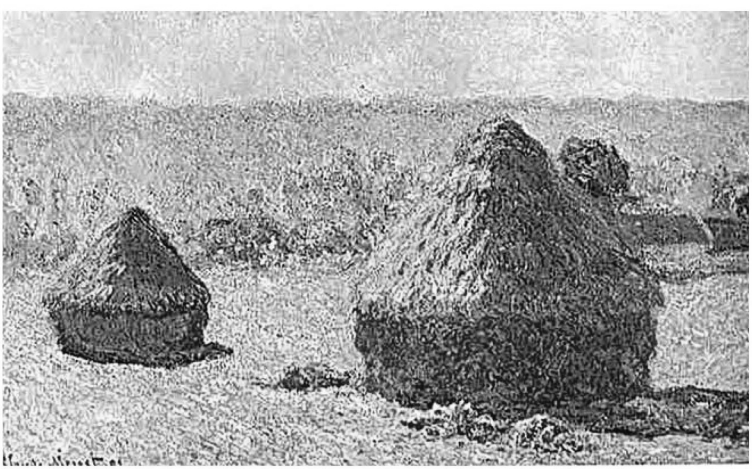


Color is Relative

of other colors – not in isolation. The two panels above contain identical blocks of color but they look very different against the background. Check out the website if you have a black and white book. It is an irrelevant question to ask if my red is the same as yours, since *my* red against one background is not even the same as my red against another.

People generally agree on naming colors but not all languages have the eleven specifically named colors of modern English: black, blue, brown, gray, green, orange, pink, purple, red, white, yellow, if you are interested. Ancient Celtic languages, so called 'gru' languages, recognized only four colors and other languages don't distinguish purple from blue. Color, or at least the naming of color, is a cultural thing.



Impressionist Painting, Monet Haystack

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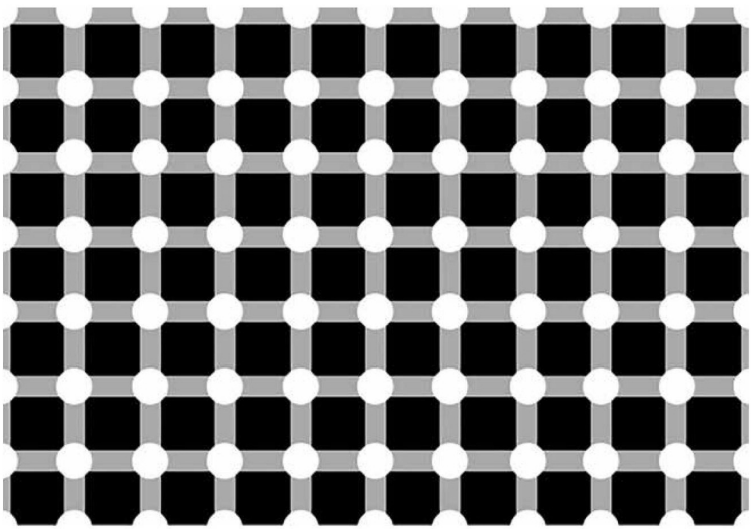
The resolution of the eye is not the same across the image. High resolution is concentrated in the center, while lower resolution black and white vision dominates the edge. This peripheral vision helps us detect predators or play football but it is not the focus of our attention. When we focus our attention on something, we turn our eyes to look at it directly. The central part of our eye is called the fovea centralis and is composed of cones. About half our cones are concentrated in this very small section and this gives us immense visual acuity. For a computer display to outperform this section of the eye it would need one billion by



Scintillating Dots Optical Illusion

one billion pixels. The fovea centralis is tiny, only two degrees across, so our eyes must dart around the image to take in all the detail. Once the basic information is encoded in our retina and sent down the optic nerve, it goes into a production line process in the visual cortex where all the elements are analyzed. Our brains extract information from the image such as texture, edges and depth perception in specialized portions of the brain. Because of this specialization it is possible to play tricks on the brain with images that are not easy to process. Some we find pleasurable, while others can be a little disturbing.

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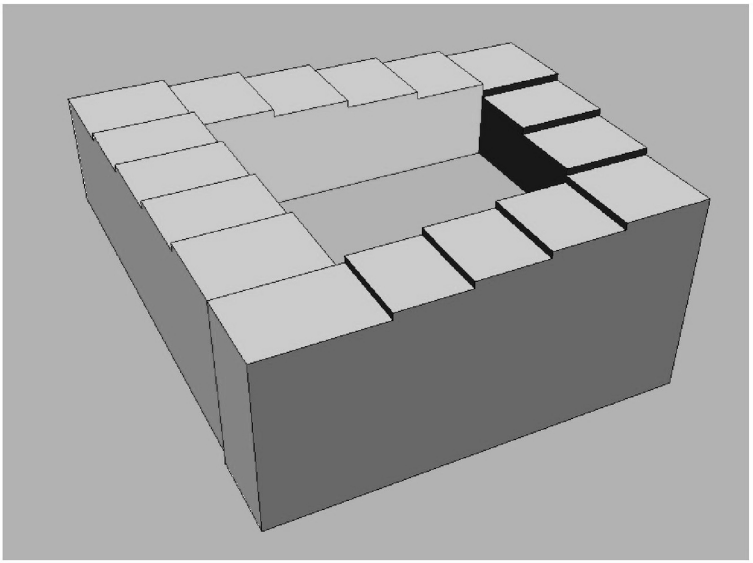

Penrose Steps

Optical Illusions

This picture is an illusion that plays with your stereoscopic synthesis. The dots appears to flip between black and white. Other illusions play with depth perception. The Penrose Steps are a type of illusion that tries to build an impossible physical model in our cerebral cortex. The brain sees perspective and depth perception cues, but the resulting shape could never exist.

Hearing

Unlike sight, hearing is an absolute sense. Our ears capture and focus sound down to the eardrum where a set of small hairs called cilia convert it into electrical impulses. The impulses stimulate cells corresponding to specific pitches.

We are born with perfect pitch, yet most of us lose it early on. When I hear Maria Carey sing a top B flat a specific set of neurons located near the ear fires, and if she sings a top 'A' then a different clump of neurons are stimulated. By the time most children come to learn music they have edited out this absolute pitch information. One group of children who do not lose the ability are Chinese pianists. Because Chinese is a tonal language – where the pitch of words affects their meaning – and because

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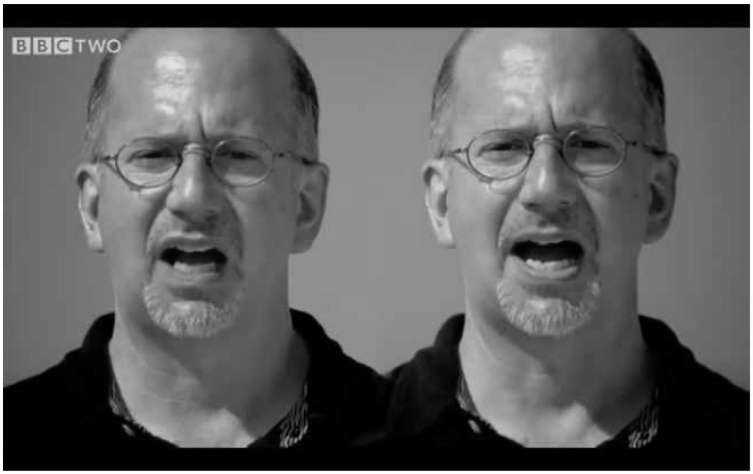

McGurk Effect; Go to the Website and Watch the Linked Video

Chinese children tend to learn the piano very young, they don't lose the absolute part of pitch. An astonishing 93% of these children develop and retain perfect pitch throughout their lives.

There are many cross connections between the audio and video processing systems. At parties you often can't hear speakers clearly because of the background noise. Watching their lips will help comprehension, but which sense wins if there is conflict between the two? The McGurk effect shows this.

To test the effect, go to the website, watch the video and see if you can distinguish when a speaker talking normally and when he is making the mouth movement of another sound. There is a winner. Try it for yourself; check out the link on my website.

Once upon a time people imagined the brain was like a camera forming an image of the world, but if this were the case there would be a paradox. Who is looking at the image in our brain to make sense of it? Modern research shows we don't take a complete picture of the world like a camera but rather parse the image into its constituent parts on the fly.

If someone asks, "Which side of the house is the tree on?" your brain parses the question and compares it with the image map in your mind's eye. What is the image composed of: trees, houses, sky, grass? Your brain manipulates the linguistic question about the relationship of elements and matches it with the visio-spatial understanding of the image, allowing you to answer the question. You might not have to answer

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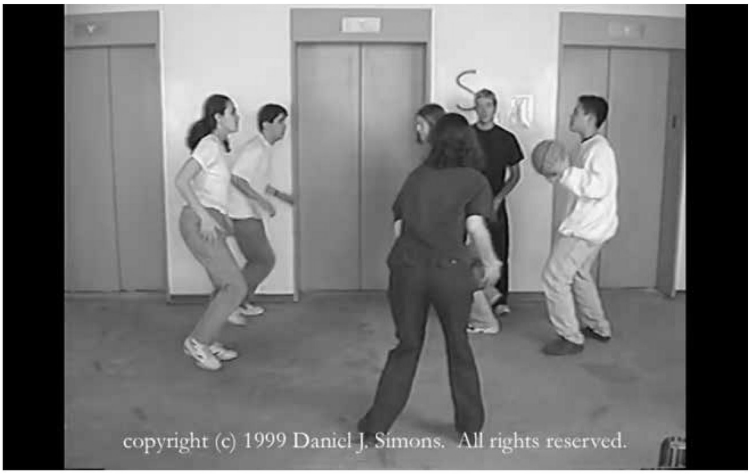


Humans' Ability to Concentrate

the question verbally. If you hit a baseball, no language is involved; you distinguish the ball from the background and perform quite a feat of tracking and calculation to connect it with your bat.

Because the brain is editing the scene on the fly to keep within its processing power, the eye only sees what it turns its attention to. Magicians take advantage of this to play amazing tricks on us. Watch the video on the web and then tell me what you see.

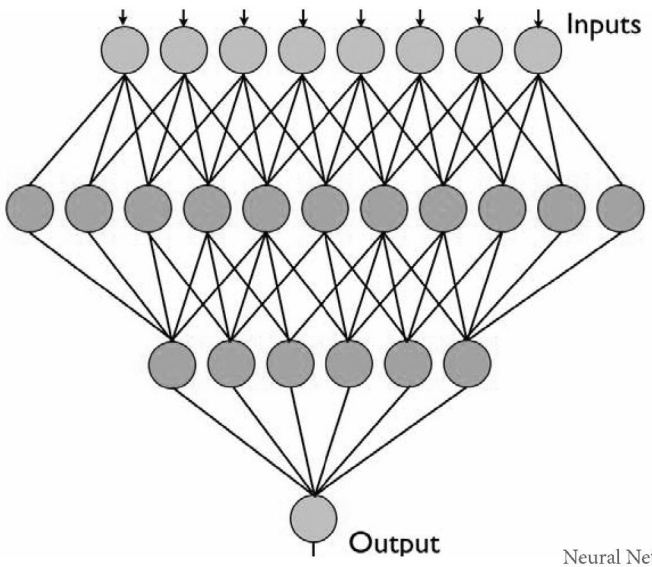
VISIT THE WEB AND VIEW THE VIDEO TO SEE WHAT HAPPENS

Tiger Woods Swing

You can see just how intensively the brain works on a given problem, throwing away all unnecessary information.

The brain contains mirror neurons, a type of brain cell that responds when we see another human do something. These neurons fire as if we were performing the action ourselves even though we are merely witnessing it. It is one of the ways we learn a skill. If I watch Tiger Woods's golf swing, my mirror neurons will fire as if I were practicing *his* swing. Later when I practice the swing for real, my neurons will have already been partially programmed. This effect is presumably the reason we enjoy watching sports; our mirror neurons allow us to begin acquiring a skill while sitting in an armchair! This is clearly a useful evolutionary trait but you *do* also need to practice for real!

Mirror neurons also fire in response to witnessing emotions. When we see an actor laugh or cry, we experience their emotion as if for real. This helps us empathize with the person we are watching and is part of the reason we enjoy movies and plays.



Neural Network

Thinking

"We cannot solve our problems with the same thinking we used when we created them."

Albert Einstein

If you feel mentally exhausted reading this book, don't worry. This is normal. Mental work takes energy. Scientists estimate the brain consumes 20% of our resting energy; around 12 watts. Physical fitness is important for thinking. If you get out of breath running for a bus, thinking is going to be harder for you. Studies are mixed about whether the additional work involved in solving a difficult problem causes you to use more energy. We certainly see an increase in the flow of glucose to the appropriate part of the brain, but the overall energy use in the brain is quite high in the first place, so it is hard to see the incremental effect.

Unlike muscles, which store energy locally as glycogen, brain cells 'burn' glucose and oxygen from the blood stream in real time. If scientists detect glucose and oxygen flowing to a part of the brain they know it must be working on a problem. As we know, there are several ways to make glucose and oxygen show up in brain scanners. You can, therefore, inject someone with the right chemical markers, wheel them into a brain scanner, and watch them learn new skills. On a practical level, there is limited space within a scanner and you can't wield a golf club, for example. Julien Doyon, a researcher at the University of Montreal, was recounting this problem to a friend and she suggested knitting. Knitting is a physical activity you learn just like a golf swing or a tennis stroke, with all the initial fumbles and jerky activity, settling down to a fluid learned skill. Most experienced knitters can engage in a full conversation while knitting complex patterns, only needing to break off and concentrate during a pattern change. Luckily, there are ceramic and bamboo knitting

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needles which don't interfere with MRI scanners, and they are small – no golf swing problems here. Studies of knitters show that when they initially learn a skill, several areas of their brain light up, but after a while, the brain activity becomes concentrated in the sensorimotor striatal territory.

Glucose, the brain's power source, is a sugar we get directly from eating sweets or indirectly by digesting starch. Some studies show children do slightly better at school if they eat starchy foods in the morning for breakfast – a bowl of cereal or porridge. When you think and work your brain consumes the glucose in your blood, and blood glucose level drops. If there is a steady source of glucose from the starch digesting in your gut, the glucose is constantly topped up and the level will stay high. If there is no input of glucose from your gut, the body will first get glucose from glycogen in your liver or generate it by converting fat reserves. This takes more work so the body tends to avoid doing so until it absolutely has to. You can function with slightly lower glucose levels but the body will shut down a little. One thing that suffers as a result is the brain's ability to perform cognitive tasks. A quick and easy way to fix this is to consume some raw glucose and most fridges have a ready supply in the form of sugary drinks. Stories of kids running amok, due to sugar highs brought on by too many sweets and sodas, appear to be an urban legend. In tests, parents told their children have had a sugar drink report them to be hyperactive even if they had been given a sugar free drink. I'm not suggesting you drink lots of sugary drinks – it is bad for your teeth and will make you fat – but the occasional soda is fine.

Memory

Scientists are just beginning to explore the mechanisms that lay down memory in the brain. There are two main classes of theory. The first believes memory is formed in the large scale wiring of the brain. Neurons connect with other neurons and the number and strength of these connections cause memory. When we learn, new connections are formed. The electrical activity in a given part of the brain triggers the formation of new dendrites. They grow, piloted by tubulin micro-tubes, rather like vines growing in a slow motion nature clip. Once a micro-tube guided filament is close enough to other, a synapse forms. This gross-scale wiring growth is one method of memory formation. Another gross-scale effect is myelination. Myelin is the insulation the body uses on nerves cells, including nerve cells in the brain. It looks a bit like the insulation we used in the 1930s. Before the invention of plastic, strips of waxed canvas were wrapped around wires to provide insulation. Myelin

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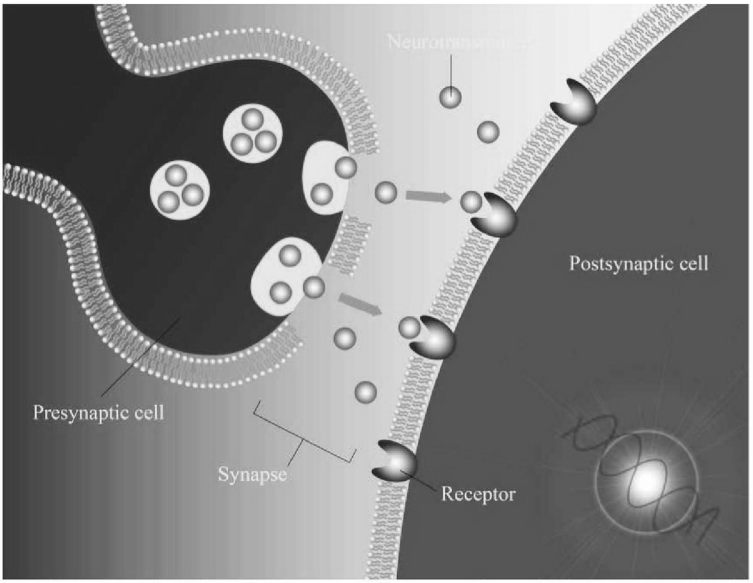

Synapse

has a similar structure. It is a flat protein laid down as a spiral on the outside of nerve cells. The theory is that cell firing causes myelination, which permanently imprints the memory.

The alternate class of theory proposes memory is encoded at a much smaller scale. Neurons are quite complex structures in their own right. Inside each neuron is a lattice of proteins, which forms a skeleton. Part of that skeleton provides structural integrity to the neuron, while other elements provide control and motility. It is this control part of the skeleton that people believe might encode memory. A 2012 paper by Travis Craddock and Jack Tuszynski of the University of Alberta, and anesthesiologist Stuart Hameroff of the University of Arizona proposes a protein called CaMKII binds to the cytoskeleton in 32 different configurations, providing a binary data encoding. It is an elegant idea but it also relies on your believing their model for quantum neuron processing which is still highly controversial. If proven, they are my top Nobel Prize tip for this decade!

Photographic Memory

Until recently conventional wisdom held that true photographic memory was a myth and the few people claiming to have it really used some sort of mnemonic memory technique to selectively memorize things. The

most famous case was a Russian journalist known as 'S'. He habitually memorized things using association with places. In antiquity this was taught as 'the method of loci'. The unusual thing was his inability to turn the effect off, and he found it as much a curse as a blessing. He was unable to forget useless information and found it hard to interpret complex images, tending to see areas of color and shade rather than objects such as trees, houses and fields.

Very recently some people have come forward, six in America and one in the UK, who appear to have genuine photographic memories It is well worth watching the TV documentary *The Boy Who Can't Forget* to gain a sense of what this is like. These people appear to lack the ability to forget, and this turns our understanding of memory on its head. It seems memory might work the opposite way we thought. We had previously thought we only remember what we pay attention to, but perhaps we must actively forget, and this ability is missing in these subjects. Scientists are studying these people to see if they can understand more about memory.

The Aging Brain

We can explode a myth and encourage older readers simultaneously. Memory does not deteriorate with age, or at least not until we are very old. Most studies looking at memory deterioration focus on the very old and compare them with the very young. Even then, the differences are small. When people are asked to attempt memory problems there is a mild drop off with age but the results are quite similar. The most likely reason older people don't remember so well is they don't believe they can. Perhaps they don't have as much incentive to remember new information. Why learn someone's name if you're unlikely to meet them again? Since IQ actually increases with age, don't believe people when they say you are going downhill from the age of 40. You are not!

Computer Brains

Computers are really quite simple compared with all the evolved baggage we humans carry around. When a computer is presented with instructions, for example, for a program like Excel and a file such as my expenses, it will load everything into memory and 'run' it. The process of running a program is simple. Each instruction is a number. The computer reads the number, looks it up in a table, finds a corresponding number, and writes that down. Essentially that's all there is to it. From a simple mechanism like this, we get the enormous complexity of a modern

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computer. The sophistication is achieved through reading and writing many numbers in parallel, and chaining the steps together so that if you read a particular number it triggers another read/write process, and so on. I'm glossing over some details such as logical functions but, if you know how a modern computer chip is constructed, my description is not far off. Almost all logic today is implemented in tables to achieve the speeds we expect from modern chips.

All modern computers are clocked. A small piece of quartz rock has been polished, coated with metal, and wired up to a control circuit in the computer. When you apply voltage to the rock it bends and absorbs energy. When the voltage is taken away it bends back and gives out the energy. This is effectively a pendulum and it can be used to make an accurate clock. I used to design these for a living. Every logic gate in a computer is connected to this clock, and each time the clock ticks the logic gates in a computer *compute*.

Most modern computers are entirely synchronous. The clock rate is set so that the gates in the computer fully recover by the time of the next tick, and every gate is therefore ready in its standard position when the next instruction arrives. The human brain does not have a central clock. Each neuron acts independently – firing regardless of whether the neurons it is adjacent to are ready or not. It is wrong to think of the brain as digital. Each neuron *does* fire and recover, but it may be triggered again before it fully recovers. This makes for a chaotic and essentially analogue operation. If one neuron fires when a second has only half recovered, then it gets half an effect. If the neuron is 80% recovered, an 80% effect. Neuron recovery time is quite long, perhaps as much as $1/1000^{th}$ of a second, and they are wired in three dimensions to as many as 10,000 other neurons. It is perfectly possible for a set of neurons to run one 'program' when they are rested and a completely different 'program' when they are 50% recovered and yet another programs if triggered from different starting locations. I have said 'program,' but arguing a brain runs a 'program' is misleading. It is not organized like this.

Neural Networks

A neural network is our best attempt at a computer model for the human brain. Each neuron is represented by an entry in a table. The entry records all the connections to it, along with the strength of each connection – these are called 'weights'. In some models the connections can be both

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inhibitors and activators like in real synapses. An individual neuron will fire if the sum of all the connections multiplied by the weights reaches a certain pre-determined threshold.

A neural network does not run a program in the conventional sense, and must be trained through experience rather like a human brain. The training process allows the weights in the network table to be adjusted to give the correct result. But, unlike the brain, you can read the weights and even save them to a disk. The neural network tables start with random settings. You show the network the letter 'A' and adjust the weights in the tables until it gives a positive answer: 'It's an A'. Repeat the process with the other letters until the network correctly distinguishes them. As you do this a computer algorithm constantly adjusts the weighting tables using a method called 'back propagation'.

At the end of the training process you can show the network some new input and see how it does. For example, a letter 'A' that is in a slightly different font to anything in the training set. Trained neural networks can perform complex tasks such as recognizing faces or making clinical diagnoses, and they can be allowed to modify their weighting tables as they work so they learn from experience in a similar way to a human brain. Strong AI proponents believe making a thinking machine is just a matter of building a really large, fast neural network and working out how to train it efficiently.

Quantum Brains

Conventional wisdom says each brain cell is a single processing unit making an on-off decision – fire, or don't fire – depending on the state of its neighbors. But, Stuart Hameroff, Professor of Anesthesiology at the University of Arizona, thinks neurons are not the fundamental information-processing unit in the brain. He suggests that this accolade should go to tubulin. Tubulin is a small, versatile protein that self-assembles into filaments rather like the way buckyballs – a magnetic children's toy – can be arranged. There are two types of tubulin molecule: α and β. They slot together and wrap around to form a micro tube about 25nm in diameter.

Tubulin micro tubes do several important things in the body. They form the skeleton of neurons and give them structure. They are involved in guiding neurons as they grow towards each other to form new connections, and they also operate in the nucleus of a cell to unzip

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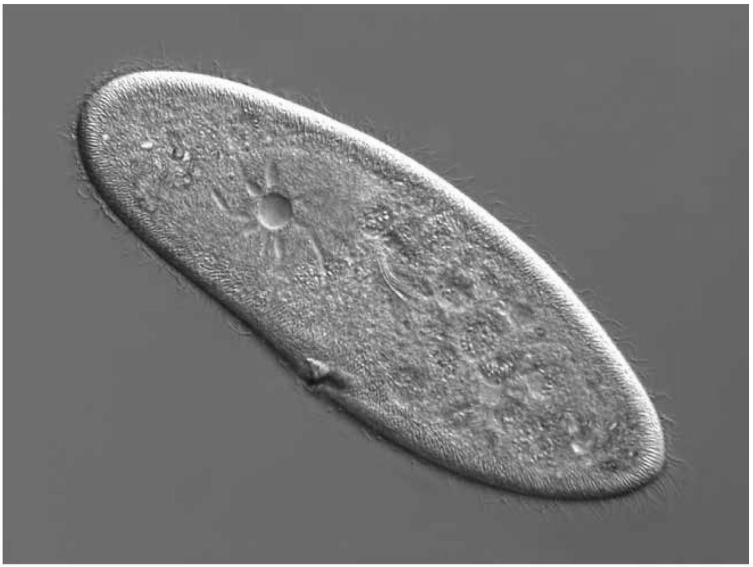

Paramecium

DNA into its two complementary strands when a cell divides. In single-celled organisms, including paramecium, the ends of the tubes stick out of the body and form the cilia that drive the organism along.

The presence of tubulin in complex, single-celled organisms provides a clue that the smallest information processing unit might not be the neuron. Some single cell organisms, such as paramecium, display complex behavior: hunting for prey and escaping danger. This suggests they can process small amounts of information without the need for a matrix of neurons. Since we evolved from these organisms, why wouldn't our brain cells take advantage of this sub-cellular intelligence?

The structure of tubulin lends itself to digital processing as the molecules forming the walls have two stable states and can flip between them. We might recognize this as the basis of a binary computer, and cells might have little computers within them. They would not need to process many bits to be useful. Perhaps single-cell organisms developed information processing capabilities in their micro tube structures that allowed them to better survive and, as their nervous systems evolved, they coupled these structures to form the brains we see today. This piece of theory is not too controversial. After all, nerves have wiring within them to carry information to the synapses and it's likely this wiring is involved in the thinking process. But Hameroff is not finished. He has teamed up with Roger Penrose to bring quantum mechanics into the picture.

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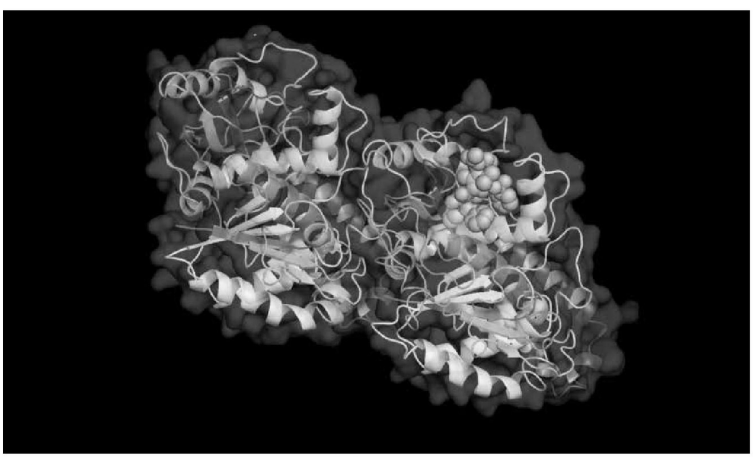
Their reasoning is straightforward but has generated a great deal of controversy. Hameroff observes that anesthetics cause humans to lose consciousness by binding to tubulin, but they do not halt all brain function. He, therefore, concludes our conscious thinking is mediated by tubulin, not the larger scale firing of the neurons. Penrose had been looking for a mechanism in the brain that would explain how brains solve non-computational problems. Together Penrose and Hameroff propose tubulin micro tubes are quantum gravity computers that allow us to think non-computationally and are the seat of consciousness. The ideas are still being worked.

Penrose and Hameroff have a difficult task conveying their ideas to the rest of the scientific community. Scientists don't recognize a need for something that can think non-computably, so they are highly skeptical of a mechanism which performs that sort of thought. The latest development on the Hameroff Penrose model comes in the work of Travis Craddock, now of Nova Southeastern University, Florida, and others. They have written a paper arguing signals propagate according to quantum principles within microtubules through the excitation of thiamin molecules along the length of the tube. They believe these molecules are quantum, entangled in a similar manner to the mechanism recently discovered in photosynthesis. The geometry of these molecules is set out in a similar way to the active areas in chlorophyll and they have a complementary problems to solve. Chlorophyll tries to maximize energy conversion efficiency, while a microtubule tries to minimize the use of energy while propagating signals along a nerve. You might wonder



Tubulin Protein

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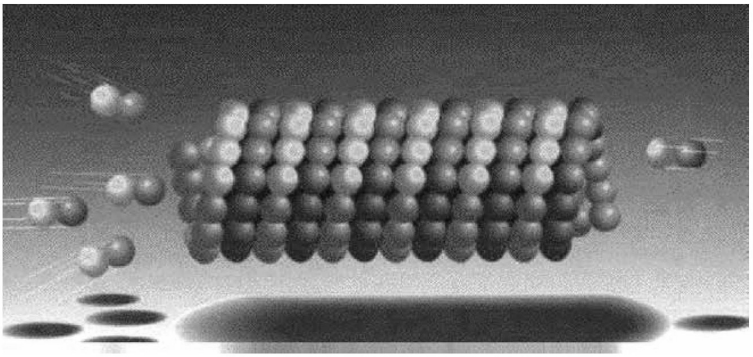
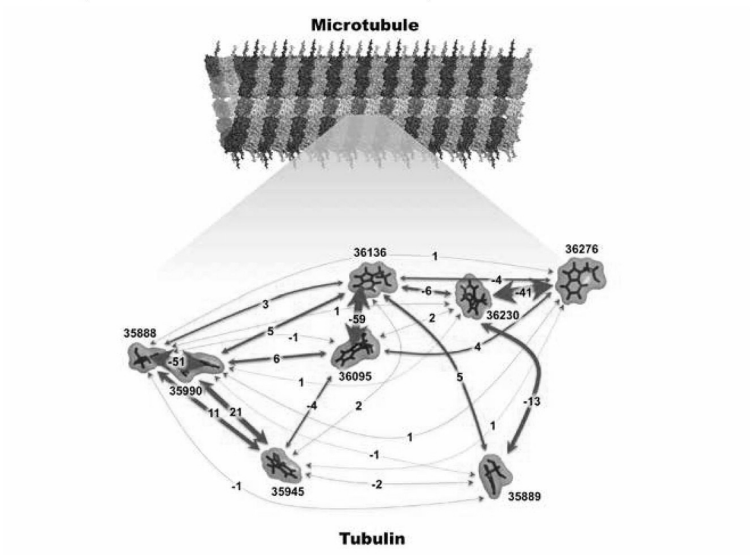


Tubulin

where the light comes from since tubulin is housed deep within the neurons inside our brains and shielded from light by our skull. It turns out that the mitochondria which powers our bodies emit photons of UV light as a waste product of their metabolism. The speculation is tubulin harvests this waste energy.

Before we argue for this mechanism any further we still need to establish that a non-computational mechanism is needed to allow human thought. In the next chapters, we will look at the nature of knowledge and, in particular, mathematical creativity and the Wiles Paradox.



Quantum Coupling of Tubulin in Microtubule

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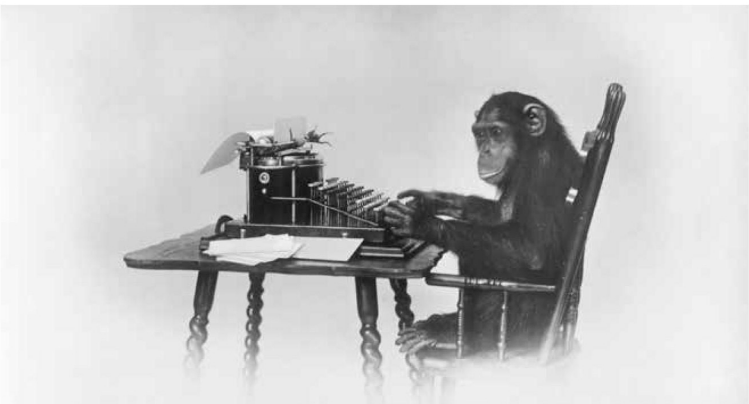
Chapter 5

KNOWLEDGE



Chimpanzee and Typewriter

"There's an infinite number of monkeys outside who want to talk to us about this script for Hamlet they've worked out."

Douglas Adams

"I'm not young enough to know everything."

J.M. Barrie

"He has Van Gogh's ear for music."

Billy Wilder

Could an army of monkeys write *Hamlet* by bashing away randomly on typewriters? Of course, we don't mean this literally. We are asking whether knowledge can be created without understanding. Can a monkey, or perhaps some form of computerized random number generator, accidentally type out the script for Shakespeare's *Hamlet* or write Tolstoy's *War and Peace*? Is knowledge generation simply a numbers game?

Leo Tolstoy's *War and Peace* is generally assumed to be the longest novel ever written. This is not quite true. Wikipedia reckons the longest novel is a French book, *Artamène*, with over 2.1 million words. Tolstoy comes in sixteenth, with a mere half million!

Written in 1869, *War and Peace* tells the story of five Russian families during the Napoleonic wars. Originally written in a mixture of Russian and French, and numbering over 500,000 words, it was quickly translated to other languages. The mistress of composer Franz Liszt translated it fully into French, where it expands to 550,000 words. Contrary to popular myth the length of the book drops slightly in German. If you really want to save paper Chinese is best. Because it uses a single symbol per word, the Chinese translation needs only 750,000 characters compared with the 3 million for English. It is wrong to assume this is necessarily more efficient than a phonetic language. Although it might save on paper, it is considerably more laborious to write. Three strokes are required to write 'war' in English whereas the Chinese pictogram requires ten.

War in Chinese

Computers work with numbers. It is a simple process to translate a book into numbers because books are composed of discrete symbols. All we need do is give each symbol a unique number and record those numbers in digital format. Artistic works involving pictures and sound are more difficult to represent because they are continuous in nature. We have to digitize them first. With music or painting this inevitably means some loss of information as we can't cut a sound or image into an infinite number of pieces.

The modern standard for translating text to numbers is Unicode. Each character is represented by a five-digit number ranging from 1 to 64,000 – two bytes for those of you who know computing. This is

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sufficient to code almost all the world's symbols, so we can avoid any accusation of being language-ist! Here are some examples of the

Φｱあ Ｑボ杏碓 Π Ж Я

Ancient Greek, Japanese: Kanji, Katakana, Chinese, and Russia-Cyrillic Symbols

characters represented by Unicode.

For our discussion, it does not matter which language *War and Peace* is written in. We just treat the symbols as numbers. I am going assume the English translation which has around 500,000 words; a nice round number. Assuming a generous 10 characters per word, *War and Peace* is approximately 10-megabytes – that's about the same size as a music track on iTunes. In practice, the book uses a bit more memory, as there is some overhead for formatting information. My laptop has a 500 Gigabyte hard disk so I could fit half a million copies of *War and Peace* on it!

If we take a look at the contents of the file on my computer the book starts:

87101108108448011410511099101441151 11

Can a computer calculate this number?

The obvious answer is YES. It is just an integer like 1, 3 or 42. Granted it's a large number, but the length of the number is simply the length of all the symbols in the book coded into Unicode – about 10 million digits. We have already determined this number can be stored on my hard disk half a million times, so it's not an unimaginably large number. How long would it take to calculate the number corresponding to *War and Peace*?

The simplest method is to count up starting at 1 then 2, 3, 4, 5, and so on until I try every number. Will this eventually get to the *War and Peace* number? The answer is yes. Eureka! All of human knowledge is computable. I have written this computation out as a simple computer program below. It says, in plain English, start at zero, go round a loop counting up one at a time and print each number as you go along.

```
i==0; Loop i++ Print i;
```

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Easy!

No, unfortunately. The problem is subtler than it first appears. First it will take a VEEEEERRRY long time. If I counted up from one, I would print out *War and Peace* eventually but it would take 120 billion, billion, billion, billion, billion… (I would need the entire length of this book to write out all the billions) years! For the physicists amongst you, I would need $10^{30,000}$ years, assuming I could use every atom in the known universe counting in parallel at the plank interval. 'The plank interval' is the shortest time that can exist in the Universe as a discrete 'tick'.

Even going at this speed using with every atom in the known Universe would take $10^{5,000}$ longer than the age of the Universe. This is stupendously long. Remember scientific notation means I have a 1 with 5000 zeroes after it. It is a deceptive notation as something as innocuous as 10^{120} is equal to the number of atoms in the known universe. $10^{5,000}$ is an absolutely enormous number. If you hear something is going to 'take until the end of time', we're talking a lot longer than that!

You may have spotted that in the process of counting up to the *War and Peace* number we also count through EVERY book ever written shorter than 500,000 words in all the world's languages. Interestingly we counted through the Japanese and Chinese translations of *War and Peace* quite a bit before we reached the English and finally French translations. During the process, we also stepped through countless other wonderful works: proofs of amazing theorems, the complete works of William Shakespeare, and every composition ever written. Sadly, we never knew it. The problem is my program never stopped and told me it had found any of these wonderful things. I would have to sit staring at the screen to spot them. If I was off doing something else – making a cup of tea, taking the kids to school – I would miss all these wonders; the program never *tells* me if it has succeeded, but quietly prints out *War and Peace* and carries on. This is really annoying. It's not a useful machine.

What I need is a machine that rings a bell when it finds something interesting so I can break away from what I am doing and take a look. Reading every book it writes in every language and all the nonsense in between would take a ginormous amount of my time. (By-the-way, contrary to statements by school teachers that ginormous is not a word – it is!) I want a computer to come up with *War and Peace* without me having to do all the work.

It's no help if the machine writes everything down and lets me take a look in my own good time. That only puts off the time when I have to begin reading all the gibberish it produced. Another practical problem is the massive storage required. Just imagine the immense piles of printer

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paper! Stephen Hawking and Jacob Bekenstein have shown space appears to have a limit to the quantity of information it can store. The quantity of information we are looking at here is greater than the storage capacity of the Universe and would collapse space-time to a black hole before I got even a fraction of the way through. Let us try to be a bit cleverer about the task of creating this information.

The simplest way to tie the computer down is to run a much stricter program. Ask it to count up from one until you get to a number representing the novel War and Peace and then print it, stop and ring a bell.

Loop i++ until i == "War and Peace…"; Print i; ring-bell;

This program succeeds!

I am triumphant. I have calculated the *War and Peace* number, and this time I did not miss the event. But, if you consider this a little more deeply I gave the computer the answer! I told it the string "*War and Peace…*" and it was able to count up, stop, and tell me it reached it. In mathematical terminology, the program is said to have 'halted' when it reached the *War and Peace* number and in computer science speak it is a special purpose program designed to do only this one thing. This program is pointless. First, it would still take a ginormous amount of time to get there and, second, it is trivially the same as running the program: Print *War and Peace*.

i = "War and Peace…"; Print i;

It's just the same as me taking my laptop, finding *War and Peace* and pressing *print*. In no way is this equivalent to Leo Tolstoy's creative effort of writing *War and Peace* in the first place.

What went wrong?

I wanted my computer to find an *interesting* string I did not already know. *War and Peace* is trivially computable after Leo Tolstoy created it but the question is whether my computer could come up with *War and Peace* or some similar creative work on its own. Can it *create* and, more importantly, understand it has *created* something? We have linked the ideas of creativity and understanding, and this will prove to be the key to the problem.

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The Problem

One suggestion put forward by Daniel Dennett is the creative process is a two-part task – generate ideas, then critically assess them. I can, in principle, make a program write out every possible book less than 500,000 words long. Provided I don't store the results this will not collapse the Universe. This just leaves the problem of writing another program to read all the output and ring a bell each time it finds some interesting truth. This second program might be called an appreciation program. Let's examine this approach. I can write out a very simple program to do this – provided I cheat and ignore the complexity of the term 'something interesting'. In plain English: Count up from one until I get an interesting fact, write it down and stop.

Loop i++ until i == (Something Interesting), Print i

This generates two problems. We need to make a program that can tell if something is interesting and it will need to be fast because it is going to be handed a huge amount of junk. Clearly I have a process running in my brain that can determine if something is interesting, but it is quite slow. It takes me an appreciable time to open a book, leaf through the pages and declare it either junk or interesting. Leo Tolstoy had a process in his brain that allowed him to create something interesting but I want to prove he did not do this by generating random junk and sifting through it. Let's look at the mathematics.

We know simply counting sequentially through every number would take too much time, but why not generate random numbers and run our critical eye over them? Surely this would give a faster result. Let us try with a short poem. How hard would it be to come across something as simple as a four-line poem using this technique?

This poem, by the late Spike Milligan, is only 23 words long, including the title, and I have a powerful computer. Wouldn't it be possible to generate it using a computer? Unfortunately, no. We humans don't have a good head for large numbers and this problem is much harder than it appears. Let's use playing cards to get a feeling for large numbers.

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A Simple Poem

Rain

There are holes in the sky
Where the rain gets in
But they're ever so small
That's why the rain is thin.
Spike Milligan

Spike Milligan

Coming upon a poem by chance can be likened to the probability of dealing a perfect bridge hand. Shuffle the deck thoroughly and then deal four hands. What is the probability every player will have the ace through king in a single suit? It's about 1 in 1,000,000,000,000,000 hands. Because lots of people play a lot of bridge around the world, this outcome has been reported quite a few times. The possibility appears within the bounds of human experience. Fifty-two playing cards seems close to the 80 characters that make up this poem and 13 choices of cards is about the same as the 26 letters of the Latin alphabet. Wouldn't we expect poems of this complexity to crop up almost as often?

NO.

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The 80 characters of this poem versus the 52 playing cards and the greater choice offered by 26 letters increases the problem geometrically. Taken together the probability of accidentally getting this poem is vastly less than a perfect hand of bridge, 1 in 10^{83} against the perfect bridge hand of 1 in 10^{20}. That's the difference between the number of atoms in the known universe and the number of atoms in a jug of water! Numbers get big very quickly when we are looking at the permutation of information. And there is another problem with our bridge analogy. All the bridge players in the world are part of the machine finding the perfect hand. When a human sees a perfect bridge hand they are amazed. It is an event that usually hits the local newspapers and a couple of years ago one reached the national papers in Britain. Each bridge player looks at every hand, they play so there is a huge amount of processing going on during every bridge game. To replicate this for our poem, we would need millions of poetry classes spending hours each evening reading through computer printouts of gibberish.

I should also add that sightings of perfect bridge hands are almost certainly hoaxes. The probability of it happening even once would require everyone on Earth to play bridge continuously for a thousand years. It is reported somewhere in the world about two or three times a year. If we are charitable, we might assume people failed to shuffle the deck properly but I suspect some mischief is going on! The numbers don't stack up…

You might think the problem is one of improving the efficiency of the filter so humans would only have to examine a smaller number of possibilities. Surely I could improve things by writing a simple program to ban all non-English characters, words and poor grammar; things that don't pass the Microsoft Word grammar checker. This would generate a more manageable number of potential poems.

Lewis Carroll shows this does not work; my idea to use a grammar and spelling checker to filter out gibberish just eliminated Jabberwocky, one of the most famous verses in the English language. Take a look at what Microsoft Word thinks of it.

HOUSE_OVERSIGHT_015825

The Jabberwocky

'Twas brillig, and the slithy toves
Did gyre and gimble in the wabe;
All mimsy were the borogoves,
And the mome raths outgrabe.
"Beware the Jabberwock, my son!
The jaws that bite, the claws that catch!
Beware the Jubjub bird, and shun
The frumious Bandersnatch!"

He took his vorpal sword in hand:
Long time the manxome foe he sought—
So rested he by the Tumtum tree,
And stood awhile in thought.

And as in uffish thought he stood,
The Jabberwock, with eyes of flame,
Came whiffling through the tulgey wood,
And burbled as it came!

One, two! One, two! and through and through
The vorpal blade went snicker-snack!
He left it dead, and with its head
He went galumphing back.

"And hast thou slain the Jabberwock?
Come to my arms, my beamish boy!
O frabjous day! Callooh! Callay!"
He chortled in his joy.

Twas brillig, and the slithy toves
Did gyre and gimble in the wabe;
All mimsy were the borogoves,
And the mome raths outgrabe.

Lewis Carroll

Lewis Carroll's Jabberwocky

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'Twas brillig, and the slithy toves
Did gyre and gimble in the wabe;
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And the mome raths outgrabe.
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Beware the Jubjub bird, and shun
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Did gyre and gimble in the wabe;
All mimsy were the borogoves,
And the mome raths outgrabe.

The Jabberwocky Spell Check

Microsoft Verdict on the Poem

39 of the 166 words in the poem are unknown to Word's spelling checker and this is an optimistic analysis of how the algorithm would fare. Many of the words are in the spelling checker because of the poem: galumphing, for example. Lewis Carroll's work was sufficiently influential that part of

the English language was created in this poem. The same goes for much of Shakespeare. If we used a filter method, we would have just deleted most of Shakespeare from the English language! Indeed half the poems in my anthology of English verse are destined for the waste paper basket due to some minor infraction of 'the rules'. If you want something that completely flummoxes my spelling checker here is the Loch Ness Monster Song by Scottish poet Edwin Morgan. I asked a Scottish friend whether Scottish spelling checkers fared any better and he assures me, no.

The Loch Ness Monster's Song

Sssnnnwhuffffll?

Hnwhuffl hhnnwfl hnfl hfl?

Gdroblboblhobngbl gbl gl g g g g glbgl.
Drublhaflablhaflubhafgabhaflhafl fl fl -

gm grawwwww grf grawf awfgm graw gm.
Hovoplodok - doplodovok - plovodokot
- doplodokosh? Splgraw fok fok
splgrafhatchgabrlgabrl fok splfok!
Zgra kra gka fok!
Grof grawff gahf?
Gombl mbl bl -

blm plm,

blm plm,

blm plm,

blp

Edwin Morgan

The Loch Ness Monster

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The foibles of spell checkers have long been a personal pain to me because of my dyslexia. Although I can see the red underlining Microsoft Word kindly inserts so liberally into my text, I can't easily see the occasions when I use a homonym. A fine poem illustrating the problem was kindly written by Jerrold H. Zar and published in *The Journal of Irreproducible Results*. It hangs on the wall behind my computer to remind me to check for these errors.

Candidate for a Pullet Surprise
By Jerrold H. Zar

I have a spelling checker,
It came with my PC.
It plane lee marks four my revue
Miss steaks aye can knot sea.

Eye ran this poem threw it,
Your sure reel glad two no.
Its vary polished in it's weigh.
My checker tolled me sew.

A checker is a bless sing,
It freeze yew lodes of thyme.
It helps me right awl stiles two reed,
And aides me when eye rime.

Each frays come posed up on my screen
Eye trussed too bee a joule.
The checker pours or every word
Too cheque sum spelling rule.

Bee fore a veiling checker's
Hour spelling mite decline,
And if we're lacks oar have a laps,
We wood bee maid too wine.

Butt now bee cause my spelling
Is checked with such grate flare,
Their are know fault's with in my cite,
Of nun eye am a wear.

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Now spelling does knot phase me,
It does knot bring a tier.
My pay purrs awl due glad den
With wrapped word's fare as hear.

Too rite with care is quite a feet
Of witch won should bee proud,
And wee mussed dew the best wee can,
Sew flaw's are knot aloud.

Sow ewe can sea why aye dew prays
Such soft wear four pea seas,
And why eye brake in two averse
Buy righting want too pleas.

The Search for Knowledge

I hope this explanation shows you the simplest model for creativity – working through every possibility, and examining them all – is doomed to failure. It would take longer than *until the end of time* to even list all the options, let alone analyze them.

You might wonder just how long it is until the end of time? It's generally assumed there are two possible ends to the Universe, a Big Crunch or heat death. Either way the approximate estimate is our Universe will last somewhere between one and fifty times longer than it has lasted so far. That's a long time, at least another 15 billion years, but just generating *War and Peace* would take 5000 orders of magnitude longer than this!

More complex models such as a three-step process have been suggested. We could perhaps randomly create information and put it through a mechanical filter to bring it down to a manageable set of options and then give it to an appreciation algorithm to finally decide whether we have created something. The real problem with this model is the filters. If we try to reduce the effort by assembling works only from pre-existing words, we will have filtered away many works we know and love. Gone are Shakespeare, Lewis Carroll, Dylan Thomas and Roald Dahl, shall I go on? Indeed, once upon a time there were *no* words, every word was coined at some point. The process of creating art is continually creative and mechanical filters can't be applied to things they have not seen before.

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You might argue we could devise a more sophisticated mechanical filter, something that contains an algorithm with an understanding of the rules of language. The problem is both the size of the task and the nature of understanding. If I devised some really good appreciation algorithm which did not delete all the creative words of the English language, it would still have to read and appreciate the huge quantities of input until it hit upon something good. There is no way for any machine to read all this information in the age of our Universe; the numbers are just too large. And there is no way for a machine to understand all the rules of language, they are not written down and constantly evolve.

These descriptions should give you an intuitive feel for nature of the creative problem. If you try to deconstruct it into mechanical steps you end up with either a mechanism that needs to be infinitely specified or one that lets through an infinite quantity of nonsense. A human could never sift through all that garbage to find the occasional pearl of wisdom.

Until the beginning of the 20th century, most people thought knowledge and creativity must be just a matter of scale. A big enough, fast enough machine should be able to solve any problem. But early in the 1930s two mathematicians – Kurt Gödel and Alan Turing – showed knowledge was not so simple. Let me give you a feel for why.

Knowing When You Know

The essence of creating knowledge, is to know when you have done so. In a sense, counting from one to infinity means *I know everything*, and merely counting to 50 million creates every piece of significant symbolic knowledge that will ever be written – all the books, plays, mathematical theorems you could possibly want. But, if I were to list all these numbers in an enormous imaginary book it would hardly constitute knowing everything: I would be awash with numbers but not with knowledge.

The essential feature of 'knowing' is to have a small number of steps that will definitely answer a problem. For example, if I wish to phone someone I can look up their details on my phone. The process will tell me their number in two or three steps. If you tell me the number is somewhere in the phone book this is not knowledge. It could mean I need an infinite number of steps.

If I accidentally deleted all the names in my phone – a nightmare scenario – and just had a print out of numbers would I still 'know' them? Obviously I would recognize my mother's number, but most of them would be useless. To know something, I need link the information to what it is for. A number with a name allows me to predict what will

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happen if I make a call. I will have an interesting conversation or pay my gas bill. It's the same with most numbers. If I have a number that represents the design for a building or a mathematical theorem, these numbers have purpose. If I input these numbers to a computer along with some building design software or a copy of Mathematica they will do something interesting; allowing a construction firm to build a innovative building or a mathematician to check a theorem is sound.

It's a lot harder to prove numbers representing art are functionally useful. A work of art is in some sense not complete – it still needs to go through the process of being appreciated by someone. We could show it to a friend or exhibit it in a gallery but this is un unpredictable process. Van Gogh's paintings were so criticized in his lifetime, many people would have denied them the label art, and Edwin Morgan's Loch Ness

Art or Information

Monster poem is almost pure gibberish, but it's undoubtedly art. Art is a tricky problem but, in practice, most of us agree on what constitutes good and bad art. We will look again at art, in Chapter 10.

Classically we assume knowledge is discovered through random chance and iteration. To understand how this might work let's lay out the world's information in a way we can visualize. Imagine every piece of discoverable knowledge could be found in an infinitely large library.

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The infinity library would contain every possible symphony, theorem, novel, poem, and play ever written, or to be written. Its sister library next door, the continuum library, would contain all the analogue works of art; painting, sculpture, architecture, physical artifacts and the like. The curators of the two libraries would constantly argue over whose collection was the better. We'll leave them to differ for the moment. The infinity library is interesting enough so let's explore it first. After all, its sister, the continuum library, takes an infinite amount of time just to look at the first room, and we are in a hurry!

Although the infinity library is infinite, we are probably only concerned with entries shorter than a million symbols. All the interesting papers, proofs and symphonies I know of are shorter than this. If I wanted to include all computer programs, I would still only need to increase it to 100 million symbols. Looking for knowledge is *not* itself an infinite task.

For the sake of clarity, I will ask the infinity librarian to organize the collection. Any book or paper will be sorted according to its title and the contents of its pages, and similar books should be grouped together. I also only want to look at the English section of the library for the moment. I will still have a huge section to look through but at least every work is titled and readable by me. Much of the information will be junk but amongst the sea of rubbish will be islands of useful knowledge. Now, is there a way to find knowledge in this library in an automated fashion?

Battleship

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The best analogy I can find to illustrate iterative knowledge discovery is the 1970s family game 'Battleship'. The game consists of two 10 by 10 grids that you plug your ships into. All the ships are linear shapes of a few squares in length. The players cannot see each other's ships and must guess where they are. A very simple way to do this would be to ask your opponent whether they have a ship on the top left square and continue systematically across the board, square by square, until you reach the bottom right hand corner. This would eventually find every ship. If every ship were a piece of knowledge we could discover all the knowledge in the world by simply stepping through the board one cell at a time, but it would take a long time.

A better way to play Battleship is to pick a square at random. If you get a hit, explore linearly around the hit. This will efficiently find the rest of the ship. The same might be true for knowledge. We could take random shots, get lucky and move linearly to flesh out our knowledge. Once we had exhausted an area we could take a step away at random and again hope for another hit. This process is exactly the way some people imagine the frontier of knowledge expands.

But, it is wrong.

The monkey moon shot story explains…

> *"I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a monkey on the moon and returning him safely to Earth."*
>
> President Monkey

The monkey nation is asked to mount a moon shot. After a little time a monkey is asked to report on progress.

"I can report," says the monkey, "I have climbed a particularly tall tree on the tallest hill on my island and have made over seven hundred meters progress towards the moon, although this is only 0.0001% of the way there, this has been quick so I believe we are well on the way."

You see of course the problem. Progress in many problems is nonlinear. Moving a bit of the way towards the goal does not provide any *actual* progress: That is the problem with knowledge. It is not linear in structure. You need to take leaps to discover new knowledge. You can not simply look around in the general area. Such leaps are mathematically huge. The chance of making a successful one by pure chance is virtually zero.

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But Cats Can!

As chance would have it, as I was writing this book about the impossibility of creating great literary works at random, our new kitten, Jessie, sat on my keyboard – she likes the warmth. To my great embarrassment I have been proven wrong. Here is her first literary work. I managed to capture her on camera a little later that evening, editing a spreadsheet. My brain interprets this string as the cat thanking me for good food. I wonder if you see the same thing? This is just a demonstration of the strength of human pattern detection algorithms and not, sadly, of feline communication.

Cats Creation

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Jessie, Our Creative Kitten

Chapter 6

KITTENS & GORILLAS

Orangutan and Kitten

"No kitten that loves fish is unteachable; No kitten without a tail can play with a gorilla; Kittens with whiskers will always love fish; No teachable kitten has green eyes; No kittens have tails unless they have whisters; hence..."

Lewis Carroll

"Once you eliminate the impossible, whatever remains, however improbably, must be the truth."

Sherlock Holmes,
Arthur Conan Doyle

As well as giving us Alice, the Jabberwocky, and the Cheshire Cat, Lewis Carroll lectured on mathematics at Oxford University. He wrote several books on logic, illustrated with wonderful problems involving fish, kittens, and gorillas – much less boring than the brown, grass-eating cows of modern textbooks. Kittens and gorillas are not usually in much contact, but I did find one hit on Google, pictured!

The words we organize into books, poems and plays are not just a random jumble; they have structure and a logic to them. We group verbs, subjects and objects together to form sentences and, at a larger scale, characters have motivations and relationships: this character loves that character, the valet had the candlestick in the ballroom and could not have stabbed the butler in the kitchen, and so on. We have dictionaries to define words, but to truly understand the information they convey we need to understand the logical rules governing how they can be combined.

Everyday conversation is fragmented and repetitive. Fortunately, now and again, we say something definitive. For example, "This gorilla is brown." The statement links a property, 'brownness', to a thing, 'a gorilla'. Logical statements are precise but often need to be put in context. If I were standing in a forest when I made my statement you must guess I mean the nearest gorilla. The word 'This' implies nearness, but nearness is not well defined. Better to be precise. 'The gorilla I am closest to, measured by line of sight distance is the Pantone shade *dark brown*.' However, if I talked like this all day I would not have many friends.

Logical Beginnings

The formal study of logic began in 384BC with the publication of a treatise called the *Organon* by the Greek philosopher Aristotle. A student of Plato, Aristotle taught many of the famous leaders of his time, including Alexander The Great. Ancient Greece was not some idyllic think tank. If you annoyed the political establishment you might find yourself having to leave town in a hurry. This happened to Aristotle after Plato's death, and he spent nearly a decade touring Europe. Eventually, he returned to Athens where he published his study on logic.

In the Organon, Aristotle examined groups of up to four statements, each containing up to four relationships. For example: All kittens eat fish. Some kittens eat fish. No kittens love gorillas. No gorillas eat kittens – luckily. It is possible to put two statements back to back and infer things.

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I could say, "All gorillas eat leaves." "All leaves are green." Therefore I can infer all gorillas eat some green things. This is a valid inference. It is *not* correct to say, gorillas eat *only* green things.

There are 256 ways you can arrange four Aristotle statements with four relationships but only 19 valid deductive conclusions can be drawn. The kitten puzzle at the start of the chapter is an example of such a logical puzzle. Can you reach the right conclusion?

TRY SOLVING THE KITTEN PUZZLE WITHOUT READING ON

Aristotle's syllogisms are only a start. There are many other types of logic. In antiquity, the Stoics developed a different brand of logic based on the idea of larger and smaller. Stoic logic allows us to answer questions of relative size. If a Mini is smaller than an Audi, and an Audi is smaller than a Rolls Royce, then a Mini is smaller than a Rolls Royce. The Stoics pursued their branch of logic until around 180AD when study of this sort died out. It's not quite clear why. Perhaps the rise of religious power and the onset of the Dark Ages curtailed intellectual inquiry. Even after the Enlightenment began around 1650 it took some time for the discipline of logic to re-emerge. If you want to learn more about syllogistic logic and how to solve Lewis Carroll's puzzle you should read his book *The Game of Logic*. The definitive book on the logic of language, in my opinion, is *Logic* by Wilfrid Hodges.

Logic for Computers

Western civilization mostly survived on syllogisms and stoic logic for nearly two thousand years before George Boole devised his theory of binary logic in 1847. Boole developed an elegant mathematical system for representing logical statements that allowed simple arithmetical operations to answer logical questions. We now call this system Boolean logic and he gave us the modern convention of using one for true, and zero for false. Computers use his principles all the time. For example, if it is true my bank account shows less than zero, then make it true that someone will send me a letter warning me I am overdrawn. The best way to get your head around Boolean logic is to solve the ancient puzzle of the Two Guards. The puzzle featured in the 1986 movie, *The Labyrinth*,

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starring David Bowie and Jennifer Connelly. If you want to cheat watch the film to see the answer. Here is the puzzle. I'll put the answer on my website.

> *Two guards stand barring your way and behind them are two doors. One guard always speaks the truth, while the other always lies. You are only allowed to ask one question of one of the guards. Your life depends on picking the right question to ask as, based on the answer, you must pick a door. One leads to life, the other to certain death. Is there a question you can ask to ensure you pick the door leading to life?*

TRY SOLVING THE GUARD PUZZLE

Twin Guards - Left door or Right

If you are reading this, you picked the correct door and lived.

Logic for Humans

Syllogisms can be used for practical purposes. Take, for example, the following set of statements, "I want a hot drink." "Coffee and tea are hot drinks." "I always drink milk with tea," "We have no milk." What drink should I choose? I'm sure you can work it out. This logical problem follows a simple chain and results in me getting the hot drink I like.

We use Boolean logic on a day-to-day basis. The simplest form is a checklist. Pilots use checklists all the time; do I have wings, fuel and a copilot? If they are all there, go ahead and fly. Otherwise do not. Mathematically speaking, a checklist is simply the product of the options. If they are all one, then the product is one – in this case we can fly. If any is false – represented by a zero – the product will be zero and we cannot fly.

Life is often more complicated and we have many logical tools at our disposal. Let's take a look at a few, starting with a famous historical one.

Benjamin Franklin invented the lightning rod and bifocal glasses, as well as charting the Gulf Stream and all manner of other scientific discoveries. He described his process for decision-making when there are many pros and cons to consider.

> *"... my Way is, to divide half a Sheet of Paper by a Line into two Columns, writing over the one Pro, and over the other Con. Then during three or four Days Consideration I put down under the different Heads short Hints of the different Motives that at different Times occur to me for or against the Measure. When I have thus got them all together in one View, I endeavor to estimate their respective Weights; and where I find two, one on each side, that seem equal, I strike them both out: If I find a Reason pro equal to some two Reasons con, I strike out the three. If I judge some two Reasons con equal to some three Reasons pro, I strike out the five; and thus proceeding I find at length where the Balance lies; and if after a Day or two of farther Consideration nothing new that is of Importance occurs on either side, I come to a Determination accordingly."*

Another important piece of logic is *reductio ad absurdum*. Reduction to the absurd allows us to disprove something because, if it were true, it would lead to an absurd conclusion. An alibi is a familiar form. If I was seen in the pub when the murder occurred in the ballroom of the manor house and you claim I committed the murder, I must have been in two places at once. People can't be in two places at once – that would be absurd. Conclusion: I am innocent!

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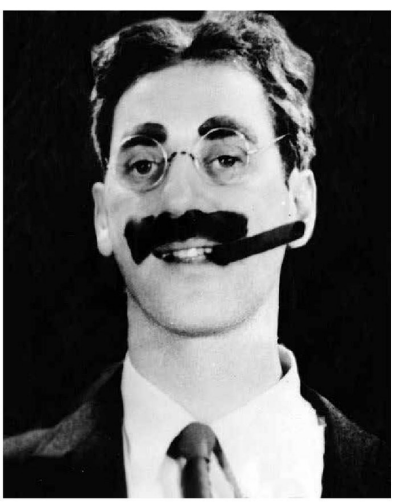
Notice I not only prove I am not guilty I also prove the opposite: I am innocent. When a mathematician uses this trick, it is called an indirect proof and works the same way as the alibi. Assume the opposite is true of some theory you want to prove (I am guilty). If it generates a contradiction or paradox (can't be in two places at once) you can deduce the opposite must be true (innocence). Mathematicians use this all the time. It assumes, of course, mathematics is consistent and that true and false are opposites.

Some mathematicians argue this is too strong an assumption. Why should we assume consistency and recognize only two logical states, true and false? These mathematicians believe the only way to prove a theorem is with positive argument rather than using the opposite of a negative argument. They don't allow indirect proofs in their mathematical models. This type of mathematics is unsurprisingly called positivism. It's a pure theory but, unfortunately, if you try to follow it you lose much of our current mathematical knowledge and understanding. Most modern mathematicians think it a historical curiosity, but it does pop up from time to time. Modern mathematics is founded on the axioms that true and false are the opposite of each other and that inconsistency is forbidden within the system. Mathematical proofs submitted to journals are not permitted to contain inconsistencies or result in paradoxes.

Paradoxes – When Logic Fails

"I would not be a member of any club that would admit me."

Groucho Marx



Groucho Marx

Paradoxes occur when a statement makes no sense, or results in an internal contradiction as with Groucho Marx's famous quote. They are widely used in mathematics to implement indirect proofs. To do this, we suppose something is true, and if it results in a paradox then the

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thing we thought true must be false and the opposite is true. This is a somewhat circuitous route to prove things, but it is often the only practical way.

Two paradoxes we are taught as children are the liar's paradox and Zeno's paradox – also known as the story of the tortoise and hare. The first is a real paradox but the second is a false paradox. The liar's paradox is just the simple statement:

"This sentence is false."

It is a paradox because of the internal inconsistency: We cannot determine if it is a true or false.

First assume it is true, but it says it is false, so it is not true. Then try it the other way around. Assume it is false but the sentence states it is false, so it must be true. If that were so it must be false by the first argument and so on *ad infinitum*.

Either way around, the sentence contradicts itself. A paradox.

Zeno's Paradox, on the other hand, is a false paradox. Here is the story.

Once upon a time there was a hare. He was a very arrogant hare and believed he could outrun any animal. A tortoise was walking along the way and the hare jumped out in front of him. "You are so slow," said the hare. The tortoise replied, "You may be the fastest hare in the kingdom but I am the most persuasive tortoise. I bet I can persuade you of anything, including that I am faster than you."

"I don't believe you," said the hare.

"OK," said the tortoise, "let me show you. Give me 100 meters head start since you are so fast. Then, we'll both start to run. After 10 seconds you will have run 100 meters and arrived where I used to be, but I will now be ten meters ahead. After another second you will be where I am now, but I will be 1 meter ahead again. So you can never catch me."

The hare pondered for a while but, being a hare of little brain, could not make out the true answer.

It is a false paradox. The time intervals are getting shorter. The question for a mathematician is, does the problem converge to a solution. The answer is yes, and I can reframe the problem to see how it is solved. Let's simply look at who would be ahead after 20 seconds: the hare!

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The mathematical reason for it being a false paradox is that some series converge and some do not. If I move progressively closer and closer to something in smaller and smaller time intervals then I may indeed reach it. On the other hand, some series never converge. I will never reach infinity how ever many steps I take.

The Barber Paradox

Now, for a slightly harder paradox, let's suppose there is a town with just one barber.

In this town, every man keeps himself clean-shaven by either shaving himself or going to the barber; the barber shaves all the men in town who do not shave themselves. All this seems perfectly logical, until we pose the question: who shaves the barber?

This question results in a paradox because, according to the statement above, he can either be shaven by himself or the barber, which is he. However, neither of these possibilities is valid! This is because if the barber shaves himself, then the barber must not shave himself and if the barber does not shave himself, then the barber must shave himself.

You might think this paradox an oddity but, using this simple idea, Bertrand Russell changed the course of mathematical history and it is the fundamental paradox used to show computers are Turing limited.

The Russell Paradox

In the late 19th century, mathematicians began to think about the nature of numbers.

What is a number?

It is certainly not an object we can hold.

I can't hold a *two*, unless it's the brass number plate, for my front door. And, in that case I am holding *one* number plate, so I am not holding the *idea* of two, but rather the idea of *one*: one brass plate in the shape of a two.

The 'idea' of a number is to say something about the *things* I have in my hand: two apples, two oranges and two brass number plates. These are all sets of two things and 'two' is the collection of all these sets.

In 1890, Gottlob Frege completed his theory of sets. The project had taken him five years. Unfortunately, just before sending the book to the publisher, Bertrand Russell wrote to him and pointed out the following paradox. What about the set of sets that does not contain itself? Think about it...

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It is the barber paradox with the word 'set' substituted for 'barber' and 'contains' rather than 'shave'. But it's essentially the same logical problem. You might find this rather contrived but mathematicians must have a system totally free from paradox, otherwise there is no certainty. Frege's system was holed below the water line.

Eventually, after much further work, a theory of sets was worked out that does not contain the Russell Paradox. It's called Zermelo-Fraenkel set theory, or ZF for short. It solves the Frege problem by forbidding sets to refer to themselves. It's a bit like Microsoft Excel's solution to dividing something by zero. It is simply forbidden and generates an error message. Set theory was fixed and is now the basis of most mathematical thinking.

What is Logic for?

Logic is the foundation of mathematics. Applying it enables us to make irrefutable statements about things: numbers, lines, planes, equations and the so on – the things you learned at school – and to prove statements about these things beyond *any* doubt. This is not the 'reasonable doubt' hurdle of our law courts, but an absolute measure: No possible doubt whatever.

Let's look at one of the earliest mathematical proofs: Euclid's proof there are an infinite number of prime numbers. Euclid created this proof in ancient Greece around 300BC – so far back that logic was in its infancy

Euclid's Elements 100AD

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and numbers had not yet been properly invented. Euclid used distances rather than numbers for all his proofs but I will use the word 'number' in this explanation.

First a little revision. A prime number is a number that can only be divided by itself and one, for example three, five, seven, and eleven. All numbers can be split into primes using a couple of tricks. First, all numbers are divisible by a set of primes. Ten is five times two – two primes. We are also fairly sure we can form any number by adding two primes together. This is Goldbach's Conjecture, set as a question in a letter written to Euler in 1742. It is still unproven!

Euclid proved there are an infinite number of primes by using *reductio ad absurdum*. Imagine we have a complete list of prime numbers – James' list of primes. It contains every prime number. (This is the setup. We are proposing something we suspect is incorrect and will lead to a paradox or contradiction. When it does, we will have proven the opposite fact. The proof relies on the fact that a number can either be prime or not prime. There is no middle ground.)

Let's make a new number by multiplying all the numbers on my list together and adding one. There are two possibilities: this new number is either prime or not prime.

If the number is prime, it is a new prime number that was not on my list and I have disproved the theory.

If it is *not* prime then it must be divisible by two prime numbers already on my list. However, neither of these numbers could have been on my list, because dividing by one of them would give me a remainder of one. Remember I multiplied *all* prime numbers together and added one. It must, therefore, be a new prime number, which had previously not been on my list. Once again, I disprove the theory.

Since both routes fail, James' list of prime numbers is not complete and, therefore, prime numbers are infinite.

Feynman's Proof

My favorite piece of logic is Richard Feynman's disproof of the existence of polywater. It's a strange logical proof bordering on philosophy, but it shows just how far you can take logic.

In 1969, an urban legend spread around the world that there was a substance called polywater. It even made it into an episode of Star Trek. Polywater was believed to be a lower energy state of water, more viscous than ordinary water. If this substance did exist, it would be possible to mine the oceans of the world converting water to polywater and

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therefore generate energy. There was a concern that if the right catalyst was accidentally introduced into the oceans they would solidify into polywater thus dooming the human race, or at the very least making water sports impossible!

Feynman was consulted and stated, "If there were such a substance as polywater then there would have evolved an animal that eats water and excretes polywater, using the liberated energy as its power source. Since there is no such animal, polywater does not exist."

Feynman's proof is an elegant indirect proof coupled with a syllogism. Polywater exists. Polywater is a lower energy form of the high-energy substance called water. Food is a high-energy substance that can be converted to a low energy substance by a process we shall call 'being good to eat.' All things on earth that are good to eat have something that eats them. Polywater is a food and therefore good to eat. Therefore an animal must exist that eats polywater. No such animal exists, so either something in our chain of logic is wrong, or the premise is unsound. Since the chain is sound, the original premise must be wrong: Polywater cannot exist.

In short, Feynman's proof says: if a thing is so, then the inevitable consequence is the evolution of something else, and since that something else does not exist, the original thing cannot be so. QED: disproof by nonexistent consequence.

The polywater disproof neatly demonstrates the important elements of Feynman's Evolutionary proof. First, life must be continuously exposed to the thing in question, in this case water. This is clearly so as most life on planet Earth lives in the oceans or is intimately entwined with water. Evolution takes time, so enough time must be allowed for life to evolve. It must be a nearly linear problem so that a solution proceeds in steps where each step is an improvement and no step requires too high a level of mutation or adaption. We can illustrate the boundary between a linear problem and one requiring a step change by describing how triple drug therapy works in the treatment of AIDS.

Until triple drug therapy entered the picture progress against AIDS had been a depressing story of drug discovery followed by the almost immediate evolution of the virus to evade the drug. The AIDS virus is a retrovirus with a shell composed of sugar molecules. It is almost trivial for an AIDS virus to mutate these outer markings to look different, even from one day to the next. This is the way the virus continually and nimbly evades our immune system. However, the AIDS virus *does* have some components that it can't easily mutate because they are not merely aesthetic, they have a functional purpose. Why not target them?

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Unfortunately, it turns out the AIDS virus can even mutate its functional parts, but this is harder. The probability of a successful functional mutation is 1000 times less likely than a simple aesthetic mutation to the sugar coat.

Triple drug therapy works by attacking three different *functional* elements of the virus simultaneously. It is possible for the virus to modify all these functional elements but the likelihood of it doing so is tiny. One mutation alone does not help because the drug cocktail will still target the other two elements and kill the virus. The AIDS virus does not understand that it is facing a triple drug cocktail. It cannot reason like a sentient being and random chance is not sufficient to make the big leap necessary to overcome the cocktail of drugs. Unless you can mutate all three elements at once your time as a virus particle on this planet is over. Most problems we have to solve in this world require more than one simultaneous logical step and these don't happen by chance.

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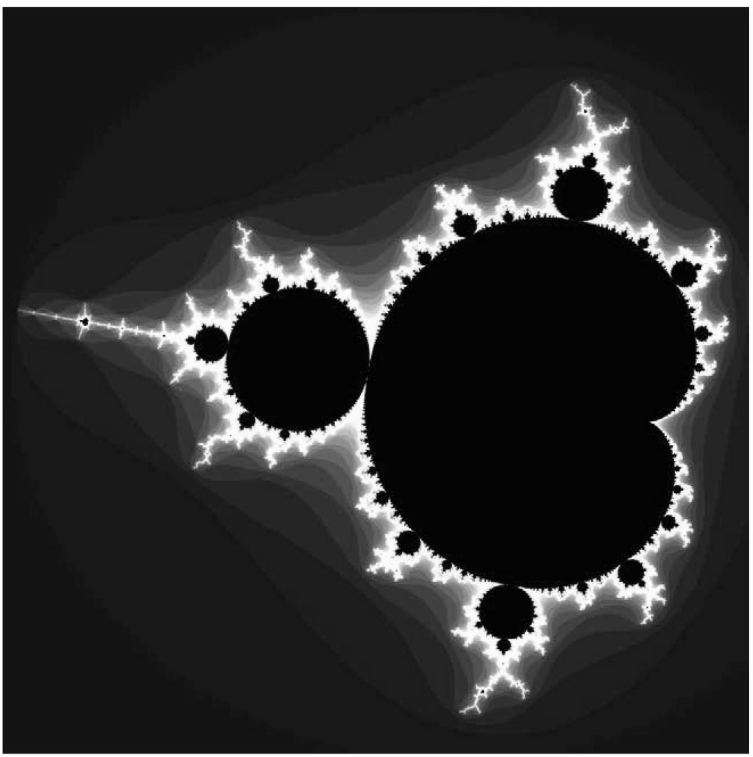
Chapter 7

COMPLEXITY & CHAOS



Mandelbrot Set

"Life is really simple, but we insist on making it complicated."

Confucius

"Any darn fool can make something complex; it takes a genius to make something simple."

Pete Seeger

There was once a great King who lived in a marvelous palace. To fend off boredom he collected all manner of interesting games and puzzles. One day an inventor came to his palace and told the King he had a game of such subtle complexity, yet apparent simplicity, the King would play no other. The King learned the game and soon agreed it was, without doubt, the best of all games. The game was, of course, 'chess'. The King asked the price of this game and the inventor told him it was a mere trifle. The King should give him one grain of rice on the first square of the board, two on the second, four on the third, and so on, doubling each square until he filled the board.

The King called his treasurer to honor the bargain and the first bags were brought from the storehouse. The grains were placed on the board in each square but soon there was not enough space and the grains had to be piled on the table next to the board. Soon this, too, was not enough and every table and chair in the hall had to be covered. Even this was not enough and they began to stack whole bags up in the courtyard.

When they reached the thirtieth square, the treasurer turned white. He sat and calculated for a while before saying with a trembling voice, "My great ruler, there is not enough rice in all the world to cover this board." The ruler called the inventor and told him he could not honor the debt and the inventor should name another price. The King had two beautiful daughters, the first knew she was beautiful and deported herself accordingly, and the second, was bookish and shy, but perhaps more beautiful for this. The inventor asked for the hand of the second daughter and lived happily ever after. In the less favorable version of this story, the King becomes very angry and has the inventor beheaded. I prefer the romantic version.

Placing rice on a chessboard and doubling it successively leads to wildly large numbers. Covering it completely requires 18,446,744,073,709,551,615 grains, about four hundred trillion tons and equivalent to one thousand years of worldwide rice production. Like the king, humans do not intuitively grasp the enormity of this problem because we're not good with large numbers.

Although the number of grains needed to cover a chess board is very large, it is not hard to calculate. The treasurer is the one who should have lost his head for not being able to do the calculation. The equation is simply two, doubled sixty-four times, less one, $2^{64}-1$. A pocket calculator can produce this number in a thousandth of a second: it's just long multiplication. Although calculating this number is quick, it is not always the case. Answers to some problems have short cuts, while others do not.

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Mathematicians have catalogued the universe of problems into classes rather as biologists have catalogued animals into species. Each problem is examined and put into a genus with a name. Sadly the names are not as readable as the Latin names for animals. For example, 'nlogn' is the complexity class of most sorting programs, while traversing a maze typically sits in the class NP or P/POLY. Although the classifications look complex the basis of cataloging is simple, a class name signifies the time needed to solve a problem using the best possible algorithm, and the scale this is measured in is 'Big O'.

Big O

Every problem has a complexity. In mathematics this is expressed using 'Big O' notation, where 'O' stands for order-of-magnitude. The simplest problems have order 1.

If I am working at my computer on a Word document and I press *print*, the printer will spring to action and print the document. This problem is of flat complexity, notated O(1). It does not matter how large the file is; one click is all I need. I am, of course, assuming sufficient paper in the printer and ink in the cartridges.

The next complexity class is a linear problem, O(n). For example, walking to the store to buy a pint of milk. The farther the store, the longer the walk. The time needed to get to the store is directly proportional to the distance: if I am walking, a single step multiplied by the number of steps required to cover the distance.

You might think adding two numbers together is a linear problem – the bigger the number, the harder the problem – but there's a clever trick to speed it up. You can get 10 people to add each column in parallel. They'll need to coordinate when someone ends up with a number larger than ten and has to carry the extra digit but this can be easily solved. A problem gets its classification only once we've used the cleverest possible trick to solve it.

Most problems we meet in mathematics are somewhere in between flat and linear but there are some that are much harder. The most common hard problem we come across in our daily lives is sorting. Rather than go through a tedious written description, check out the video link on my website. Sorting without using any spare space requires a bubble sort. This is an example of something that needs n squared operations and, since n squared is the simplest example of a polynomial, it is said to be in the polynomial time, or 'P' time classification.

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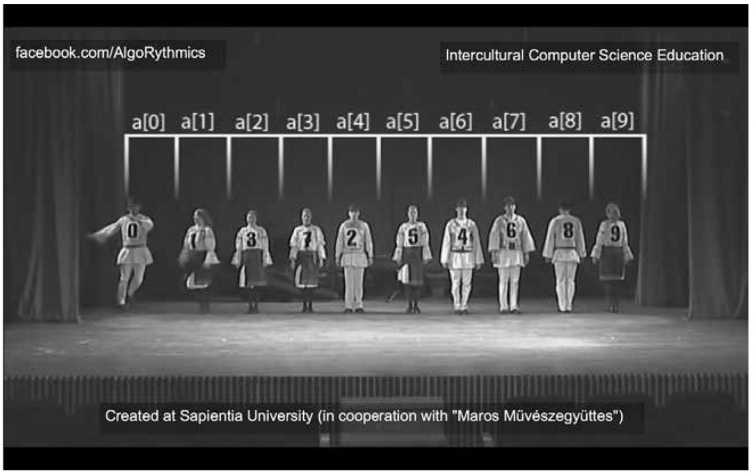

Bubble Sort Ballet

The Hardest Problems

You probably hope cracking the encryption used to secure the Internet is one of the hardest problems known to man but I'm sorry to tell you it is not. When you use your credit card to buy something from an online shop, your web browser changes from *http* to *https*, the 's' stands for secure. The data you send to the Internet is coded using a system developed in 1977 by Ron Rivest, Adi Shamir and Leonard Adleman of MIT, which is why it is called RSA encryption. Any information you send is raised to the power of a very large number – usually around one hundred digits long. Raising something to the power simply means multiplying it by itself that many times.

What makes decrypting a message hard is that division is a slow process; it is called 'long division' for a reason. It turns out there is no way to speed it up on a conventional computer so, unless you know the right number to divide by you will have to try *every* number. It is this that makes decrypting RSA messages hard.

Although RSA messages are difficult to decipher, they are nowhere near the hardest problems. That accolade is commonly believed to go to non-deterministic polynomial problems known as 'NP' problems. NP problems are easy to describe but fiendishly difficult to solve. Nondeterministic means each time you come to a branch in the problem there is no way to tell which branch is the best to pursue without exploring it all the way to the end. It's the same as a maze; at each junction in the maze you can decide which path to take, but the junction gives you no

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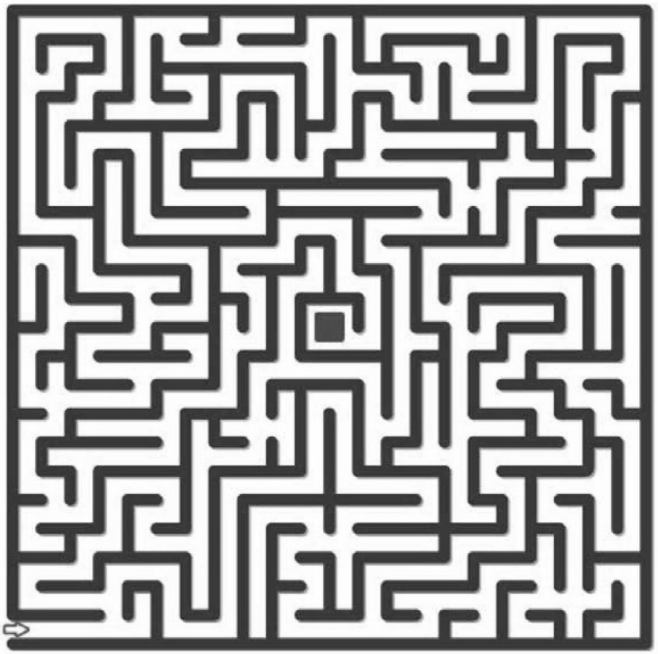

Maze

clue which one will be better. Beware the confusing naming system, 'N' stands for *nondeterministic* in this case, whereas in normal complexity classes 'n' stands for *number*. Sorry. That's just the way it is. Let me give you an example of one of these NP problems.

Let us assume we have one of those complicated recipes from the latest celebrity chef cookbook. If all the ingredients can be bought from one store, making the dish is straightforward, but if they come from different stores, you will have your work cut out. What is the best order to visit them? With 2 shops, it's trivial. Either order will do. With 3 it is a little harder and with 4 there is quite a bit of choice. This is known as the 'traveling salesman' problem because the original formulation described a salesman wishing to find the shortest route between all the cities in which he had customers. The complexity of this problem rises much faster than the Rice and Chess Board problem. Try it for yourself. It doesn't matter if you imagine you are visiting customers or shops. I have given you a grid to count off distances. Try to solve a problem for 3 cities, 5 and 10. What is the shortest path allowing you to visit each place?

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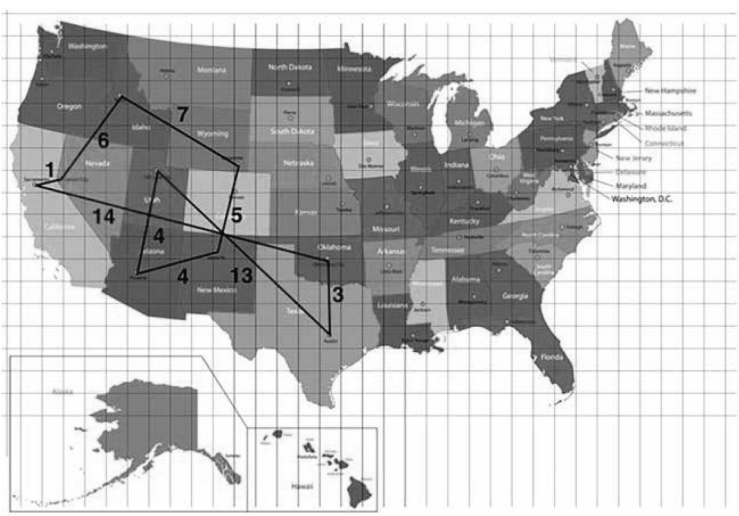
TRY THE PUZZLE ON THE WEB

Warning: Don't spend too long on these problems.

The reason I warned you not to spend too long is that solving the 50-city problem would take longer than the age of the known universe. NP problems get harder very fast as the number of elements goes up. A 50-city problem is hugely larger than a five-city problem, not just ten times harder.

The Clay Mathematics Institute has offered a $1 million prize for anyone who can say whether NP problems are really as hard as they appear. It may be there is a general trick or a series of tricks that allow you to solve any NP problem in a shorter time. If you could do this, the problem would be demoted to P, allowing fast computers to tackle it. No one has yet found a proof of the P=NP problem. At the time of writing several proofs are sitting with the Clay Prize judges but don't hold your breath. Most people assume there is no solution. If you want to have a crack at the problem let me state it in simple terms.



Traveling Salesman

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Imagine you wanted to find the center of a maze. Is there a way to speed searching the maze, so you do not have to test every branch? If you can provide a mathematical proof that there is or is not, you win the prize.

Places Game

While it is commonly assumed NP problems are the hardest, this is not the case. There are quite a few that are harder still. One such is called a PSPACE problem. It's quite difficult to explain but luckily many of you will have played a form of it on long car trips when you were a child: My family calls it The Places Game.

I will pick a place – 'London,' and you must then pick another place, say, 'New York', that starts with the letter my place ends with. I'll then pick 'Canterbury' and my kids will laugh at my dyslexia and I'll have to switch to 'Kansas' and so on. Once you use a place you can't use it again.

The mathematical question is to predict who will win given each player has a finite list of places they know? It turns out this type of problem is even harder to solve than an NP problem. This is because on each turn a player gets to pick any name from their list. With the traveling salesman problem, there is only one 'player' – the salesman – so we can write out a route and check it. In the Places Game there is no single route through the game because, after I pick my favorite town 'London,' you can pick any place beginning with 'N'. I have to anticipate an enormous table of possible paths through the game. The table takes huge physical space – which is where PSPACE gets its name.

Remember I'm just playing the simplest mathematical games with bits of paper and discrete ideas. I haven't strayed into the quantum world yet. That brings with it a whole new level of complexity to explore. Complexity is such a diverse subject that Scott Aaronson of MIT has created a web site called the *complexity zoo* to catalogue all the different 'species'. It is much to complex to reproduce here but let me provide a sketch.

The Complexity Hierarchy

My table below represents the hierarchical complexity of knowledge. We start off with the problems both humans and computers find easy, then rapidly move onto problems that even the fastest machines find difficult: a perfect game of chess or predicting the weather. Above these computable problems are the non-computable ones which no computer

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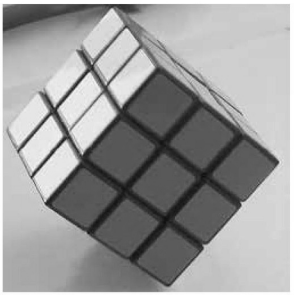
running any algorithm can solve, and then there are the free will problems: how do we pick a problem in the first place? How do inventors come up with problems no one had ever thought to solve in the first place, such as the invention of the Rubik's Cube?



Ernő Rubik's Cube

Problem	Example
Flat	*Print File (for Human)*
nlogn	*Searching a list*
Linear	*Finding the lowest number in a list*
Logarithmic	*Long Multiplication*
Exponential	*Long Division*
P	*Most Algorithms*
Near NP	*Factor Prime Number*
NP-non-complete	*Perfect Game of Chess*
NP-Complete, tractable	*Travelling Salesman, SAT*
Chaotic	*Weather*
NP-Complete, Quantum	*Modeling a Quantum Process*
NP-Complete, intractable	*Busy Beaver, Towers of Hanoi*
PSPACE	*Graph Problems, Places Game*
Non-computable	*Creativity, Finding Fermat Theorem for a Turing machine, Tiling the plane with Penrose Triangles*
Non-deterministic, Non-time divisible, Non-computable	*Free will*
Impossible	*Halting problem for a Turing Machine, some mathematical theorems such as the Continuum Hypothesis in ZF+AC (Hilberts 1st). Travelling faster than the speed of light. Understanding the American tax code.*
Known Unknowns	*I know that I don't know either way.*
Unknown Unknowns	*I have not thought to ask that question yet. Inventing the Rubik's Cube*

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Butterfly

"Does the flap of a butterfly's wings in Brazil set off a tornado in Texas?"

Philip Merilees, improving on Edward Lorenz

Chaos

Chaos is the twin of complexity. It burst into the public psyche in 1987 with the publication of James Gleick's book *Chaos*. It's not a difficult concept to grasp. Complex systems can be formed using simple rules, and very small changes in starting conditions can profoundly affect future events. I experience this if I miss my train to work in the morning: 30 seconds either way will change the whole pattern of my day, the people I meet and the level of stress I experience. I'm sure you can think of similar experiences.

Henri Poincaré, a French mathematician, first studied the effect back in 1880. Poincaré was trying to solve an old mathematical problem called the Three Body Problem originally set by Isaac Newton. Take the Earth, Mars and the Sun. These three bodies orbit each other, or strictly speaking a point in space somewhere between them. Is there an equation that will tell you where the bodies will be in, say, 100 years' time?

Poincaré

The answer is surprising, no. The three bodies will orbit in a non-repeating way. There is no analytical short cut, no equation that will predict where they will be

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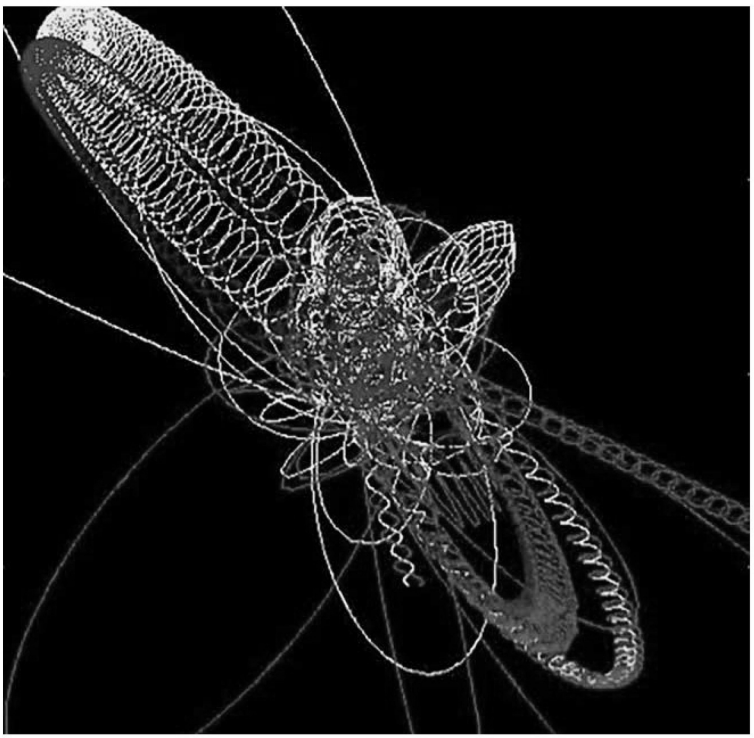
at some point in the future. The only way to know is to build a perfect model of the system and see what happens. Poincaré won a valuable prize for his proof from the King of Bavaria. You can see some amazingly complex orbits plotted below. Remember these are still deterministic and predictable – after all, they were calculated with a computer – they are just chaotic.



Four Body Problem

Butterflies and Sliding Doors

After Poincaré, the field of chaos remained fairly quiet until Edward Lorenz began studying weather patterns using computers in the 1960s. The story goes, one day his computer was misbehaving and he had to re-key some data into the machine. Rather than using eight decimal places he used only six to save time, and was amazed when the results of his program came out completely different. Dropping the seventh and eighth decimal place represents a change of only one part in a million, yet the patterns of weather predicted by the computer were completely altered.

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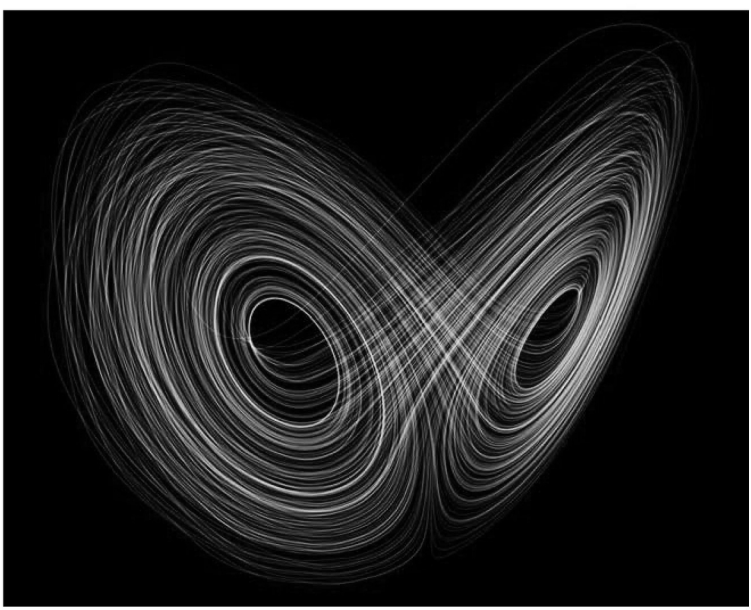
Lorenz went on to study the effect and created a new branch of mathematics. His quote about the beat of a butterfly wing creating tornados has entered the public psyche and is central to the plot of numerous Hollywood movies. One of his functions – known as the Lorenz Attractor – nicely illustrates the nature of chaos. A very simple equation plots the beautiful, apparently three-dimensional, non-repeating shape.

Chaosville

Chaos, taken to its logical conclusion could explain our Universe. Stephen Wolfram in *A New Kind of Science*, makes the argument that simple rules could explain the extraordinary complexity we see in our Universe. He applies rules to elements in a two-dimensional grid programmed on the computer which form 'cellular automaton' that function a little like simple animals, generating all manner of complex shapes and behaviors. The inspiration for this approach is almost certainly Conway's Game of Life developed by John Conway in the 1960's. In his computer game, animals and machines seem to appear on the screen but in truth they derive from the most simple set of rules. You can check out the website to see a live version of Conway's Game of Life. It's a lot of fun. Wolfram's



Strange Attractor

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thesis is that we could all be living in one of these games. Perhaps our Universe is a form of Mandelbrot diagram – albeit a 3D version with stars and planets. If you look at the picture of a nebula and compare it to the Mandelbrot set, you can see how this is a tempting conclusion.

In the Game of Life the rules are simple yet the behavior simulates little animals being created and destroyed. Of course, there are no actual animals. The things you see on the screen, 'gliders', 'walkers', and 'cannons', just hang together accidentally. But, Wolfram considers these little digital creatures *are* animals. He argues our Universe is just like the Game of Life: A set of simple rules leading to complex behavior. If we are

Nebula

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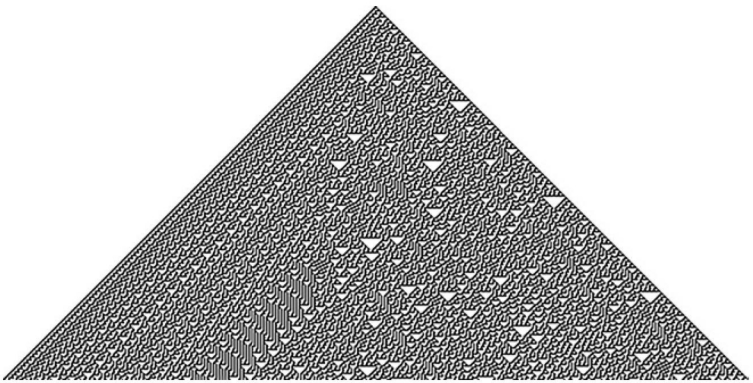
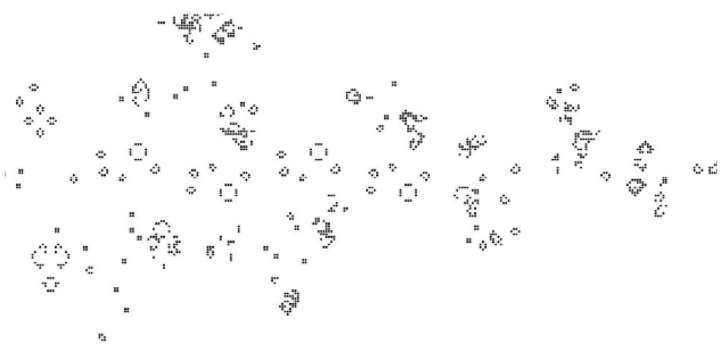


Cellular Automaton

prepared to call ourselves animals, so should the little creatures which emerge within the game. We simply emerged in a similar but slightly more complex game.

This proposal would mean our Universe is entirely deterministic, our lives the result of a gigantic computer program that we live within and form part of. Chaos might make it impossible to predict the future without running the program and watching what happened, but the results would be inevitable, set in motion at the dawn of time. There is no place for free will in such a Universe, no place for reason. The world would simply be.

But a strange idea will come to our aid to show us the limits of computation and allow us to question whether we live in a predetermined world. This idea is Aleph 1 – something larger than infinity. And it is infinity we will explore next.



Conway's Game of Life

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Chapter 8

Hilbert's Hotel

"All infinities are equal, but some are more equal than others."

George Orwell, paraphrase

"Only two things are infinite, the universe and human stupidity, and I'm not sure about the former."

Albert Einstein

"God gave us the integers, all else is the work of man."

Kronecker

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Health warning! The man who discovered infinity had a mental breakdown. This subject may tax your brain.

Georg Cantor didn't really 'discover' infinity but he was the first mathematician to put it on a firm theoretical footing. In the late 19th century, most mathematicians thought infinity was a curious idea with no proper place in mathematics. They treated Cantor's attempts to make it into a real mathematical object with contempt. This affected Cantor's morale and caused him to suffer several bouts of deep depression, retreating to a sanatorium from time to time.

Infinity is a difficult idea to grasp but it is vital to our study of information. It behaves counter-intuitively but is not impossible to grasp. The reason it is important is that information can always be translated into numbers and numbers go on to infinity. If you want to know all about information, you must understand infinite numbers.

History

Indian scholars began studying infinity in the 4th Century BC. It turns up naturally in all manner of places. In geometry, parallel lines extend forever in either direction without ever meeting. To define a parallel line you must contemplate infinity. In arithmetic, even if you pick the largest number you can imagine, there is always a larger one; just add one. In the physical world if you look up at the night sky it appears to go on forever. Again you have infinity.

Historically there were two interpretations of infinity. The first, favored by Plato, was a journey. When you embark upon a journey, you can always take another step. Infinity is the idea of 'one more' or never-ending. It can never be reached. The second definition is more radical. Infinity is a thing, a number *so big* you could not imagine anything bigger, but it is *one* number. Plato thought this second definition tantamount to madness. Today we embrace this madness and go a whole lot further. Let me show you how.

If infinity *were* a number, you should be able to perform mathematics with it; add it, multiply it, and even raise it to a power. This is not as radical as it might first seem. Until comparatively recently, zero was not accepted as a number – if you consider recent to be one thousand years! Nowadays it is.

At the end of the first millennium Indian scholars found, against their intuition, that you can use zero as a number without generating contradictions. Take addition. I can have zero cakes, add one, and I have one cake, add another, and have two cakes and so on. In this way,

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the number zero behaves just like any other counting number. It also works with multiplication. If I have zero lots of 4 cakes, I have no cakes. Zero times four is zero, so multiplication with zero works. There is one embarrassing exception, if I divide by zero I seem to get infinity. When I was a child this was a definition for infinity, but nowadays mathematicians simply forbid the operation. Division by zero is not allowed and if you try it on your computer, you will get the not terribly useful, #DIV/0! Error. That's progress I guess!

Zero had been tamed. What about infinity?

Cantor showed that while you *could* think of infinity as a number, it might not be just one number. He proposed there are many infinities. In fact, there are a greater than infinite number of them! He did this through a rigorous analysis of a new branch of mathematics called set theory.

Set theory is now the cornerstone of modern mathematics, but it was treated with suspicion in Cantor's time. Rather than embrace the new thinking, many mathematicians ridiculed it; Poincaré wrote that Cantor's ideas were a grave disease infecting the discipline of mathematics! This seems odd given our modern propensity to embrace innovation, but the tone of science back then was different: innovation was not necessarily considered a good thing.

At the turn of the 20th century, scientists were on a mission to tidy things up. Lord Kelvin announced in 1890 that mankind had discovered everything there was to know and the role of future scientists was simply to catalogue and observe the consequences of these laws, and to improve the accuracy of measurement. The last thing scientists wanted was a completely new set of numbers that behaved in strange ways. Cantor was upsetting the apple cart, but he was in good company. Just a few miles away in Berlin, a young Albert Einstein was beginning to study physics in his spare time. Those studies would culminate in his four papers of 1905, two on Quantum Mechanics and two on Relativity, ushering in the modern age of physics.

How to Count

To understand infinity you need to count in a particular way. You're probably used to counting with numbers. You count apples: one, two, three, and say, "I have three apples." You can do the same with oranges. If you have three apples and three oranges, the totals are the same and you can declare you have the same number of fruits. This is the first way to count.

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But there is a second way of counting. Take your apples and put each next to an orange. If they match up, you can easily see they are equal in number. "Look," I say, "I have the same number of apples as oranges." This method is more primitive and does not require the concept of numbers, but it is very useful. If I'm a shepherd I can hold a set of counters in a bag, one for each sheep. To ensure all my flock are gathered in for the night I drop one counter into the bag as each sheep enters the enclosure. I don't need to give the counters number names.

The Munduruku tribe, from the Amazon rainforest, have no concept of number names beyond five. Their counting system simply goes one, two, three, four, five, many. Yet this second way of counting allows them to function successfully, deciding whether two groups of things have the same number of elements, even if there are more than five of them. For example, if they need to determine if they have enough spears for a hunt, each person simply stands next to their spear. If everyone has one, they're ready. If not, then the empty handed Munduruku simply make one. No need for pesky numbers or mathematics lessons.

This second way of counting is particularly useful when tackling infinity because we are not sure what infinity is. Treating it the same way the Munduruku treat the number 'many' is the safest thing to do. The first question we would like to answer is whether all infinite things are the same.

Spears and Hunters

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We know from our childhood that infinity plus one is still infinity. Is there anything we can do to make infinity bigger? Perhaps multiplying infinity by infinity will do the trick.

Infinity times infinity can be visualized as a square with edges of infinite length. We can show that this square is the same size as a one-dimensional infinity through a clever trick – the zigzag method. Mark the infinity square into a grid. Start in the corner square, go across, diagonally down, then across, diagonally up, and so on. I'll draw you a picture. We visit every square in our grid using a single line. We can then lay down our infinite zigzag line next to the infinite line of one of the edges. The lines are the same length as they are both infinitely long! So infinity, times infinity, can be matched to infinity, they are the same. Cantor thought this a very strange result and wrote to a fellow mathematician, Dedekind, *"Je le vois, mais je ne le crois pas!"*, "I see it, but I don't believe it!"

If you are struggling with this, don't worry. We just jumped forward to quite a complex concept. Let's take it more slowly. One way to get a better grip on infinity is through the stories of David Hilbert and the Infinity Hotel.

Infinity for Dummies

Hilbert's Hotel is a mythical building with an infinite number of rooms. Other than this strange feature it is a regular hotel complete with minibar, dodgy TV, and slightly mad manager. The rooms are numbered sequential starting at one, then two, three, four, and so on. The hotel allows you to play a series of mathematical games to see how infinity behaves.

Are there the same number of minibars as there are rooms? That's easy. I said *every* room has a minibar. We can use the matching technique to match minibars with rooms. Go to the first room. There is a number on the door and a minibar inside. The same goes for room 2 and 3 and this goes on forever. I've just proven two infinite things are the same – rooms and bars, but I still have not shown you why the zigzag line is the same length as the edge line.

When you first explain infinity to a child they immediately ask "What's infinity plus one." A particularly smart kid I met, Dermot, asked, "What's infinity plus three?" Hilbert's Hotel allows us to answer this problem in a way we can visualize.

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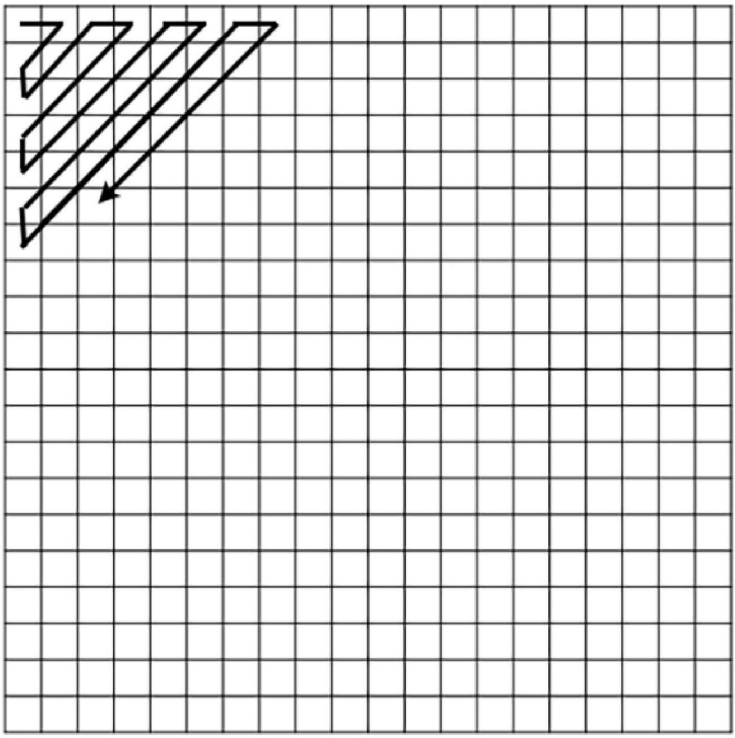

Traversing an Infinite Plane with a Line

The infinite hotel is full. A man comes to the front desk and asks for a room. The hotel manager says, "I'm terribly sorry, but we are full… But I may be able to help you. Let me think." He ponders for a moment and then says, "OK – I've found you a room." He calls the people in room 1 and asks them to move into room 2. He calls the people in room 2 and explains that due to a double booking they must move out of their room to let the people from room 1 in. But it's OK; they can move into room 3. Everyone moves up a room and the new guest gets the checks into the now vacant room 1.

This is a little harder to understand. We did not have a perfect one-to-one match as with the rooms and mini-bars. We had a mismatch of guests to rooms. But, we were able to show it is possible to re-establish a one-to-one match by doing something to every guest, having them move up a room. There is no problem with the last guest because it is an infinite hotel, there is no last guest! Another way to visualize the problem is to ask ever hunter to pass their spear to the right in the picture below.

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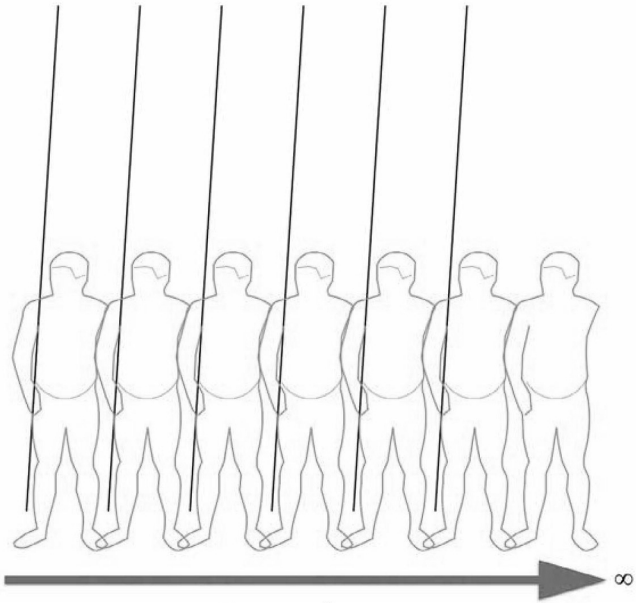

Hunter with Spears

Provided there are an infinite number of hunters there is always someone to hand the spear to and the person at the front of the line now has space for another spear.

You can probably see how to answer Dermot's question. The hotel manager calls the guest in the first room and asks him to move 3 rooms up rather than one. He then calls the remaining guests and tells them the same thing. Thus, he has managed to fit three more people into the infinite hotel. Infinity plus 3 is infinity. You may worry that it takes the manager an infinite time to call all the rooms, but it's OK; he lives infinitely long so it all works out.

What about fitting an infinite number of new guests into the already full hotel? Surely then we will get stuck.

No, Hilbert's Hotel can fit an infinite number of extra guests. Here's the trick: ask all the people currently in the hotel to move to the room with double the number they are currently in – 1 goes to 2, 2 goes to 4, 3 goes to 6, and so on. Now all the odd numbers are empty and you can fit an infinite number of people into the empty odd rooms. Infinity plus infinity is infinity. Voila.

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Now, a very clever or annoying student asks, "What happens if an infinite number of infinitely large buses arrive at the hotel. Can they all fit in?" The mathematical question is "does infinity times infinity, equal infinity?" Let us ask all the guests to get out of the bus and line up in the parking lot in neat rows. Passengers from bus one in line 1, those from bus 2 in line 2, and so on. All the guests now form a two-dimensional grid. We already know how to map a two-dimensional grid to one-dimension using the zigzag method. We can fit them all in the hotel and we are done!

Is Anything Larger than Infinity?

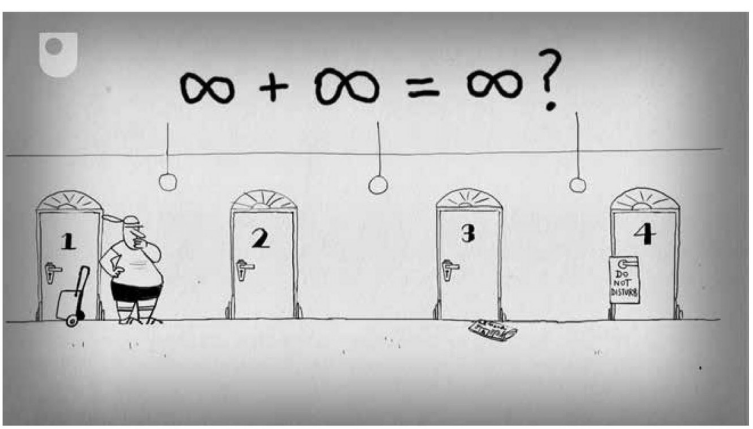
Is there any bus or combination of buses that would cause the manager of Hilbert's Hotel a problem.

The answer is yes and it involves a subtle change to the contents of the bus.

An infinite number of buses turn up but this time the buses are filled with men and women. The hotel manager is asked to put everyone in a room and once again he obliges using the zigzag method.

At the end of the process the tour guide comes to him. "I think you have missed some people," he says. "Since I am just one person, I know you can fit *me* in. But, I have a whole bus in the car park you completely missed."

"No," says the manager. "I did every bus."



Infinity Plus Infinity Equals Infinity

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"Ah, no," says the tour guide. "The first bus you accommodated had a man in the first seat but this has a woman. The second bus had a woman in the second seat but this one has a man and so on. This bus has a different gender in at least one seat to every bus you so far accommodated. It is a new bus."

The manager finds room for the passengers from the new bus but the tour guide comes back a moment later.

"You have missed another bus. This one has a different gender in at least one seat to every previous bus, including the one you just accommodated. It looks like there are an infinite number of buses you missed, all lined up to get into the infinite hotel."

What is it about *these* buses that make them so difficult to accommodate? They are all just filled with people after all.

The manager is defeated by the more complex information held in the contents of the buses. An infinitely large bus full of binary information has more information in it than an infinitely large bus specified only by its size. This is a larger infinity than the counting infinity. The permutation of all the possible options for the occupants of the bus is larger than infinity.

Real Numbers

What about the real world we live in? Is the larger infinity we failed to fit into Hilbert's Hotel present, or was it just a mathematical fiction? Hold up your thumb and index finger for a moment. The gap between them is a distance. Most likely this is a whole number with an infinite decimal digits after it – say 2.2320394386.... centimeters. The infinite set of decimal digits in this measurement is the larger type of infinity: called the continuum. Distances in space form a continuous unbroken line of points, with no gaps in between. The counting numbers, on the other hand, form a broken line. We take discrete steps from one number to the next. This is a hard distinction to grasp but it is the same distinction we used in Hilbert's Hotel. Imagine you believe you have a list of all the real numbers in the world. You can take the first decimal digit from the first number and add one, the second digit from the second number add one and so on generating new numbers not on the original list. Therefore, you cannot have a list all the real numbers; they are not countable. Let's take a closer look at these real numbers.

Here's a quick test. Which is the larger number, the first or the second?

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Holding a Real Number in your Hand

First: 3.12332498375834621364214723 74
Second: 3.12332498375834621344214723 74

You have 2 seconds to answer!
TRY ANSWERING WITHOUT READING ON

The first is larger. I changed one digit. Can you see?

Notice, you need time to read each digit and process the information. If you were an obedient reader and attempted it in two seconds you either guessed or gave up. Two seconds is too short to take in all the digits.

Let me give you another test. Again, I'll ask you the question, "Is the first number larger than the second?"

First
3.12332498375834621364214723751646464646464636…
Second
3.12332498375834621364214723751646464646464636…

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I know you're looking for the difference but you won't find one, as I did not have time to write the numbers out in full. The $10^{20000th}$ digit is different, but even if I took the whole age of the universe and counted as fast as possible I would not reach this digit. Any number greater than, $10^{120}/10^{-43}$ digits cannot be distinguished from another in the age of the observable universe. Real numbers are in practice subject to an uncertainty principle. Some mathematicians even wonder whether they really exist. But, they do exist in our minds and our thought experiments. In my view, any model of the Universe that ignores them is likely to be wrong.

Random Numbers

Which of the following numbers is random?

11111111111111111
34289460370124001
49293741762343083

THINK ABOUT YOUR ANSWER THEN READ ON

Each of the numbers could be random. There is no reason any set of 10 digits is more likely than another, but it feels very unlikely that if I tried to generate a random number I would get 15 consecutive digits. What a human means by random is a jumbled up number: one with varying digits that have no real pattern. An American mathematician, George Chaitin has been able to explain this by saying that a random number is uncompressible. This means there is no way to describe the number more efficiently than writing it out in full. A string of ones can be compressed. "Write a million 1s" takes only 18 characters, yet accurately describes a number that is a million digits long. By contrast 8988376132 can't be compressed very much at all, its information is just a jumble. There are many interesting numbers around. Some numbers are *Hamlet*; some numbers are pi. One interesting number is the following: 17733173332032037377. It is the genetic sequence for the virus smallpox, or at least the first 20 digits. Copies of the full sequence sit under lock and key in the Pasteur Institute in France and the CDC in Atlanta. This number is a candidate for an 'evil' number. You might think there are many numbers that could represent smallpox because there are

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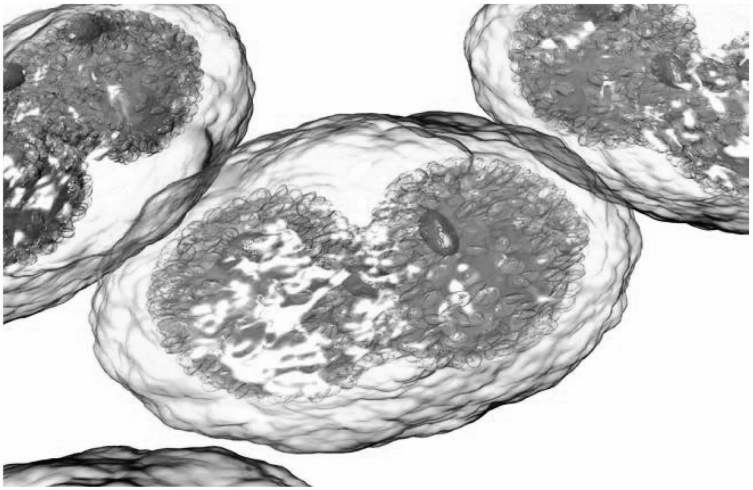

Smallpox Virus

many languages in the world and many ways you could code the genetic sequence of GATC. But, there *will be* one most efficient binary coding for smallpox and that number is the nearest we have to an evil number.

The other important element of random numbers is the process by which they are created. Computers can't genuinely generate random numbers. The numbers they generate are predictable and eventually

Child Survivor of Small Pox

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repeat. To create the random number in my example above I went to www.random.org, a website that uses fluctuations in atmospheric quantum noise to generate random numbers. As far as we know quantum effects are truly random and have neither rhyme nor reason.

Numbers are more complex than they first appear. They are infinite, yet there are different infinities, and they have meaning. The smallpox example above and the Turing numbers we will discover shortly suggest numbers *do* have meaning independent of culture and language. The next two chapters will show us what happens when we think about the meaning of numbers. We will also explain one more 'super infinity' and this will be the key to understanding creativity.

> *"There are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns - the ones we don't know we don't know."*
>
> Donald Rumsfeld
> United States Secretary of Defense
> (2001-2006, 1975-1977)

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Chapter 9

KNOWN UNKNOWNS

Donald Rumsfeld

In the spring of 1981, London staged its first marathon. The field of runners included 1200 international athletes and 20,000 amateurs. An estimated 20 million viewers watched from around the world. The top international runners stayed together for the first twenty miles and then two runners, American Dick Beardsley and Norwegian Inge Simonsen, made a push for the finish. They were long-standing rivals and, as they ran the final mile each man challenged the other to see if they could get ahead and gain the advantage. Because of the fine balance human muscles maintain between anaerobic and aerobic metabolism, the small set advantage could prove insurmountable. The other runner would need to sprint to catch up and the resultant lactic acid generated would turn their legs to jelly. As the two runners neared the finish line they glanced at each other, smiled, reached out and held hands as they crossed the line. Who won?

We all instinctively know the answer. The race was a draw, but the rules of the International Athletics Federation are clear. Read rule 164.

RULE 164

The Finish

1. The finish of a race shall be denoted by a white line 5 cm wide.
2. The athletes shall be placed in the order in which any part of their bodies (i.e. torso, as distinguished from the head, neck, arms, legs, hands or feet) reaches the vertical plane of the finish line.

The organizing committee held a brief conference and the result declared a draw. They had interpreted the rules in the same way 20 million TV viewers already 'knew' to be true.

This story should set your minds thinking about the nature of *rules* and *truth* and how the two are often different. According to the *rules*, one person crossed the line a little ahead of the other. The *truth*, as we all instinctively know, is that the race was a draw. Maybe the rulebook is missing a rule – 'The contact draw rule'. Clearly you could amend the rulebook to add this one rule. I checked the current athletics rules and they don't contain this amendment. If the rules were amended the mischievous amongst you will realize an unsporting athlete could grab the hand of their opponent as they crossed the line to force a draw. The rules would have to stipulate that holding hands must be voluntary for both parties, and refinements could go on for some time. What if I held your hand but you tripped and let go? What if my attempt to hold your hand

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caused you to trip? You could go on forever, generating rules to cover every eventuality.

Clearly, in the fuzzy world of human endeavor, truth and rules often part company. Yet, we all assume mathematics is free of such uncertainty. Let me tell you this is not so. The brilliant mathematician Kurt Gödel proved this when he was just 22, and his proof says something fundamental about the nature of knowledge.

Kurt Gödel

The story of his discovery involves some of the greatest mathematical thinkers in history. My introduction to it came about from a chance accident. I became ill in my first year at University (mononucleosis, otherwise know as glandular fever, if you're curious) and was eventually sent home to recover. Lying in bed for two months is boring. So to pass the time my mother suggested I read Bertrand Russell's, *The History of Western Philosophy*. I think she figured I had plenty of time, so picked a thick book. This nearly 800-page tome charts the entire history of philosophy from the time of the ancient Greeks. I presumed Russell was a philosophy professor, but he was originally a mathematician. He was a mathematician. And because he lived and worked productively for almost all of his 97 years, spanning much of the 19th and 20th centuries, he crops up repeatedly as a central figure in many areas of intellectual life. Russell the politician, Russell the philosopher, Russell the mathematician and Russell the peace campaigner are all the same man – not, as I had incorrectly first guessed, a prolific family. In his early career, Bertrand Russell was a Fellow of Trinity College, Cambridge, working on a broad range of mathematical problems. Meanwhile, in Germany, his contemporary David Hilbert, also a polymath, held the chair of mathematics at Göttingen University. Both men shared a common objective: to tidy up the loose ends in mathematics and set down the rules once and for all. This movement was called Formalism.

Formalism

David Hilbert and Bertrand Russell believed you should be able to set out all the rules of mathematics even though it might be a complicated affair. Without contradiction or inconsistency you should be able to

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write down the rules and then play the 'game of mathematics' to derive every possible truth. Hilbert despised the idea that there could be unknowable things and was a forthright speaker. His battle cry was: *Wir müssen wissen — wir werden wissen!* "We must know — we will know!" He believed there were no fundamental unknowns in the world.

Donald Rumsfeld famously summed up the problem of unknowns in an attempt to clarify a question from a journalist at a Whitehouse press conference:

> *"There are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns – the ones we don't know we don't know."*

Interestingly Donald Rumsfeld, like Bertrand Russell, is another person to span a huge swath of time in the public eye. He was both the youngest and the oldest serving U.S. Secretary of Defense, serving under both Richard Nixon and George W. Bush. We will shortly discover Rumsfeld's convoluted view of the world turns out to be closer to the truth than Hilbert's tidy mathematical aspiration.

As well as believing there were no unknowable unknowns Hilbert thought mathematics was completely abstract. You did not need to know what you were talking about. Whether the symbols meant dogs, cats or numbers all you needed to do was apply the rules and all would be well. His belief is captured in his quote below.

"It must be possible to replace in all geometric statements the words point, line, plane by table, chair, beer mug."
David Hilbert

Geometry with Beer and Furniture

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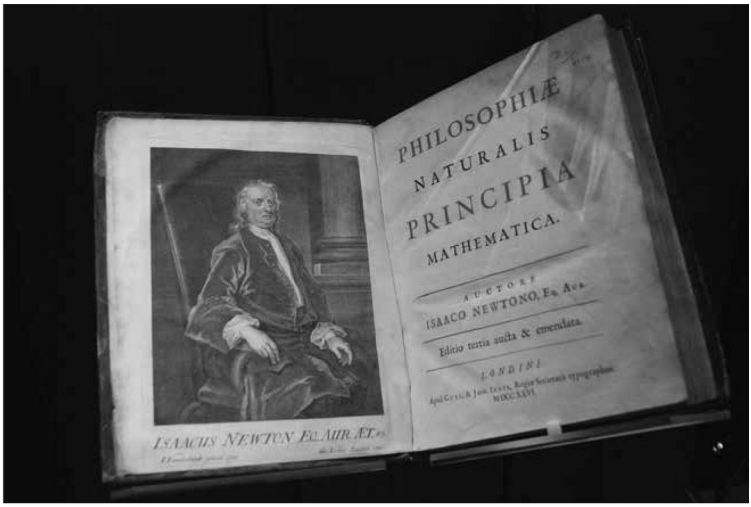

Newton's Principia

PM

In 1890, the Cambridge mathematicians Alfred North Whitehead and Bertrand Russell embarked on the mammoth task of writing out all the rules of mathematics and publishing them in a set of books called *Principia Mathematica*. Every rule is written down in meticulous detail. The books are heavy going and look like more like computer programs than text. They set out precisely what you can, and cannot, do with numbers, and are the most impenetrable textbook you will ever read. Just to give you a flavor here is one line where Russell proves 1+1=2. It has taken about 100 pages of densely packed equations to get to this point!

$$*54{\cdot}43. \quad \vdash :. \alpha, \beta \in 1 . \supset : \alpha \cap \beta = \Lambda . \equiv . \alpha \cup \beta \in 2$$

From this proposition it will follow, when arithmetical addition has been defined, that $1 + 1 = 2$.

One Plus One Equals Two, PM

PM is a 3-volume set of books. Volume One costs £480 on Amazon. This is a significant work and a collector's item. The last time a first edition volume came up at auction in 2007 it went for over £800. Cambridge University Press printed only 750 copies and I suspect they

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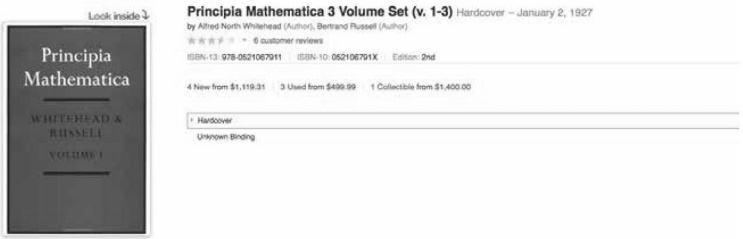

Amazon Listing for Principia Mathematica

are undervalued. When mathematicians use the letters 'PM', they are usually referring to Russell and Whitehead's *Principia Mathematica* rather than the afternoon.

Hilbert's Problems

In 1900, while Russell and Whitehead were in full flow writing out their rules, David Hilbert was invited to deliver the annual lecture at the International Congress of Mathematicians in Paris. He asked a mathematician friend what subject he should pick for the talk and, in a moment of inspiration, the friend suggested laying out a vision for the future of mathematics. Rather than tell people how wonderful mathematicians were, and why their discipline was the pinnacle of human scientific endeavor, why not try modesty and list all the problems on which they were stumped? Hilbert liked the idea and devoted his talk to all the problems he thought mathematicians would solve in the 20th century. Hilbert's Problems were simply an intellectual challenge. He offered no prizes. At the turn of the 21st century, the Clay Institute created the Millennium Prizes for solving the most important modern mathematical problems. Each solution wins a prize of a million dollars!

There are 23 numbered Hilbert Problems in all: ten in the original lecture and a further 13 in the written transcript. In 1928, he clarified the 2nd and 10th problems, refining them into three distinct questions: Is mathematics consistent, complete and decidable? Ironically this means that Hilbert's 23 problems actually number 24! The most important Hilbert questions where these last three. They ask whether Russell and Whitehead would be successful – can you write out all the rules of mathematics and then simply calculate the answer to any problem or derive any proof. This is known as the Decision Problem. Can you mechanically decide any mathematical question without doubt? To explain Hilbert's Problems, I need to define mathematics properly.

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Giuseppe Peano, Mathematician

"A mathematician is a blind man in a dark room looking for a black cat which isn't there."

Charles Darwin

The Game of Math

One of my most vivid childhood memories is driving my mother distraction by asking the 'why' question. Most children go through this phase:

Me: "Why is a sponge wet?"
My mother: "Because it has soaked up water."
Me: "Why has it soaked up water?"
My mother: "Because it has small holes in it."
Me: "But what makes water wet?"
My mother: "Because it is made of wet stuff." a bit weak now.
Me: "What is wet stuff?"
...

You can ramble on indefinitely unpeeling a never-ending onion. Sometimes, if you are unlucky, you may get stuck in a loop. For example, "where did the chicken come from?" "An egg," "and where did the egg come from?"...

Mathematics breaks this cycle!

In mathematics, there is no danger of an infinite number of 'why' questions because at its core are a clearly defined set of absolute rules called axioms. You cannot ask the 'why' question of an axiom. It is a RULE!

Starting from an absolute minimum of fundamental rules everything else is built up so that no step requires any leap of faith nor generates any contradiction. Let me give you a concrete example and, in the process, show you how numbers are defined.

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Numbers

It was not until the late 18th century that numbers were properly codified. The mathematician Giuseppe Peano gave us the rules, so they are called Peano axioms. Here are his 'axioms' in natural language.

Peano Axioms

1. The first number is named zero.
2. Every number has a next number (called its successor). Example: the next number after one is two.
3. Numbers are singular. Every number with the same name is the same thing.
4. If something is true of a number, it should be true of the next number (the successor number).

From this we can prove some very simple things.

1+1=2. Because the next number after 1 is 2 and '+1' means take the successor. (You can see I cheated here a little and did not take 100 pages for the proof.)

Back to my poor mother: "Why is the lowest number zero, Mummy?" "Because I say so!" Or, at least "…because Mr. Peano said so." That's what an axiom is.

"OK, but why is 3 greater than 2."

"Because I said that each number has a thing that comes after it.

"But, why can't 3 come after zero!"

"It can!"

"But then, if 3 is the thing after zero, I could count 0, 3, 2, 4…"

"Yes, if you want to…"

"I'm sort of lost. Now, you are saying that 3 doesn't really 'mean' anything. It just comes after 0."

"Yes. You can make up any symbols you like. You just have to remember what you said and be consistent."

The dialogue shows the importance of definition in mathematics. I could define my counting numbers as 0, 1, 2, 3, 4 or as o, π, ρ, σ, ς, or 享, 仇, 仕, 仝 or to be really annoying and confusing 0, 3, 1, 2, 4; they are only arbitrary symbols. It helps us to learn the numbers because 1 is a single line, 2 is two lines joined, three is basically three lines looped together, and four is four lines, but we could have used any symbols we cared for. It is the rules for manipulating these symbols that are the important part and give mathematics its meaning.

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The Game of Mathematics

When I was a child, our living room carpet had a square pattern. You could use boiled sweets to play checkers on it. Even though there was no board and no pieces, it was clearly a game of checkers because we followed the right rules (with the one exception that if you jumped over a sweet you got to eat it). Mathematics is like a game with a set of rules. If you follow the rules, you are doing mathematics.

Consider the simple mathematical theory that if A equals B, then B equals A. This seems clear-cut, but you can get into trouble if you're not careful when defining the word 'equals'. 'My dog equals naughty' does not imply 'naughty equals my dog. Here I have used 'equals' to mean 'has the property of.' My dog has the property of being naughty. This is an attribute, not equivalence. You must be careful with mathematics. A equals B implying B equals A is a property of numbers when the equals sign is used to mean equivalence.

Here are the rules of the game that provide a proof for this theory.

Let us start with the position in which we don't know whether A equals B implies B equals A. We have these three axioms, call them rules for now since we are using the game analogy.

Rule 1: If I have no minus sign in front of a letter I can assume there is an invisible + sign there.
Rule 2: If I have a positive letter (or a letter with no symbol in front of it) I can put a minus in front of it and put it on the other side of the equals sign.
Rule 3: I can swap the plus and minus signs of all the letters in my equation if I do it to all of them.

Now I am ready to prove my theorem.

A = B is the same as +A = + B. (rule 1)
+A = + B is the same as -B = - A (rule 2 done twice)
-B = -A is the same as B = A (rule 3)

Success.
So A = B is the same as B = A.

I have my proof. It might be glaringly obvious, but that's not the point. The point is you can apply rules to symbols and derive new rules. It does not matter what the symbols are or how obvious it is. Here's the same proof with dingbats.

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Rule 1: If I have no glyph in front of a symbol I can assume there is an invisible Ψ there.

Rule 2: If I have a positive letter (or a letter with no symbol in front of it) I can put a ♮ in front of it and put it on the other side of the ➤

Rule 3: I can swap the Ψ and ♮symbols of all the symbols in my equation if I do it to all of them.

The proof in symbols

♈ ➤ ß is the same as Ψ ♈ ➤ Ψ ß. (rule 1)
Ψ ♈ ➤ Ψ ß is the same as ♮ß ➤ ♮♈ (rule 2 twice)
♮ß ➤ ♮♈ is the same as ß ➤ ♈ (rule 3)

Any collection of symbols will do. The symbols have no meaning in themselves other than the meaning we have given them. A tribe in the Amazon jungle could demonstrate a proof without knowing any mathematics. All I need say is, "Hey, I want to play a game with you. Can anyone make this into that, in the fewest possible steps, while obeying these rules?"

But, is it true we can ignore the meaning behind the symbols. Does it matter that we were talking of numbers rather than spears, counters, or crocodiles? If we look at the marathon winning analogy again, we know the nature of a game is important. In a running race we can interpret holding hands to mean the two athletes are treated as one, the existing rules can then be applied as normal and the pair become a single winner. But, in tennis, there would be a problem. I wouldn't want to come on court and find I'm playing against two opponents! On consideration though I'd be happy if they had to hold hands while they played so that they constituted a single player. When we examine the actual circumstances, we can add a rule and show the rule works, but we have to see something about the specific sport that makes the rule fair and workable.

Hilbert was convinced mathematical truth is not like this and that proofs follow from the rulebook without any knowledge of the circumstances, i.e., the sport being played or any other analogous thing. He was to be proven wrong by Kurt Gödel.

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Königsberg Bridges

Gödel

Gödel studied mathematics at Königsberg University, Hilbert's hometown. Königsberg is famous for having a mathematical problem related to the seven bridges that link the city together. It's quite fun to try to solve. Find a route across the city that crosses each bridge once and once only. You can start anywhere, but no walking halfway over a bridge and no swimming!

Euler discovered a rigorous mathematical proof that there can be no solution in 1735 after five hundred years of failure by other mathematicians. The answer is you cannot.

In 1931 Kurt Gödel, then working at the University of Vienna, proved mathematics *is* like our sporting analogy. There are true statements in mathematics that cannot be proven by the rules of the system. Someone outside the system, with common sense, can see a statement is true, but it's impossible to prove this if you constrain yourself inside the system. It is the equivalent of all the members of the London Marathon Committee wondering what to do about the race while all of us watching the TV are shouting, "It's a draw!" Looking at the rulebook 'really hard' doesn't help.

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You have to step back and think about the problem in the round and then devise some additional rules to handle the circumstances. Mathematics is like this also.

Here is how Gödel proved his result.

It is easy to turn logic or any text into numbers. That's how this book is stored on my laptop. All we need do is translate sentences into ASCII or Unicode. In this way, any theory can be reduced to a string of numbers.

Since Gödel's proof predates the invention of the computer, he had to come up with a novel way to store information. He deployed an old Roman invention; a substitution code. The number one was represented by 1, two by 2 and the symbols by larger numbers, for example, '=' was coded as 15 and so on. He then raised a sequence of prime numbers to the power of each of these codes and multiplied all the results together. This generated a single enormous but unique number that he could later factor back into its constituent parts to recover the information. This is a truly complicated solution to a very simple problem. Today we would solve it by storing each number in the memory of a computer as an array.

Let's use the easier table method to store things and code as follows: 000 will stand for 'start of proof'. Each step in the proof will start with 00 and each symbol in the proof starts and ends with a zero. This way we can code one plus one equals two as follows.

000000111045401110121022200000 0

I think this is simple enough for you to guess the coding scheme. Hint: 111 stands for 1. The scheme is on my website if you can't work it out. Using this technique, any series of mathematical statements can be turned into a number. As a series of mathematical statements is a proof, we can generate proof numbers. They are just the sequential list of all the instructions. These numbers are sometimes referred to as Gödel numbers.

Gödel's next step was to say one number *demonstrates* the proof of another number. For example, the number 000820962 might demonstrate the proof of another number 000398... This is the mathematical equivalent of my saying a Word file demonstrates the truth of your mathematical theorem. Any statement can be represented by numbers, provided you have a consistent coding scheme that allows you to get back to the meaning.

Now Gödel set up his paradox:

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Every correctly formed theorem number has another number, which demonstrates the proof of that number.

If this is universally true there should be no contradiction. Unfortunately if you apply the theorem to itself you get something similar to the liar's paradox.

"This proof number is not a proof of the truth of this theorem number."

The proof number proves the theorem number is true, but the truth of the statement is that it can't be a proof of the statement... Paradox.

The only way to resolve the paradox is to go back one step and realize that not *every* correctly formed theorem number has a proof number using only the rules of that system.

Concisely, Gödel's theorem says, "Within any formal system of mathematics there can be statements that are true but are not provable using only the rules of that system."

When Hilbert heard of Gödel's proof, his first reaction was anger. After all, he had spent 30 years of his life trying to prove mathematics was tidy and complete. Gödel had just shown it was not. Hilbert never worked on formalism again, but the rest of the mathematical establishment largely ignored the result. Gödel's proof did not stop mathematicians proving new theorems nor doing useful mathematics. They went on much as before, using a mixture of intuition and analysis. The only difference was someone had told them analysis alone would not succeed. The repercussions of Gödel's theory have more to do with understanding our place in the Universe and the nature of knowledge discovery. These are 'big' philosophical questions, which don't greatly affect the day-to-day ability of a mathematician to do their job. However, it is important to understand that knowledge discovery is not simply analysis. Knowing this helps us understand human creativity.

Inconsistency

In the proof above, I said the only way to resolve the paradox is by saying there cannot be a proof number for *every* mathematical statement and therefore mathematics is incomplete. There is one other way to solve the paradox, and that is by allowing inconsistency into the system. Gödel's proof assumes you can prove something true or false, but what if you could prove it true *and* false? In this case, the system is complete but you can prove truths and untruths within it! This may seem an acceptable solution, but inconsistency in a mathematical model is a cancer that will

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spread through the entire body. Think about it. If I am allowed to prove anything either way, of course, my system is complete. It can say anything it wants, but the proofs I make are worthless.

Let us imagine, for a moment, we created a new system of mathematics where all the numbers in our new theory behave as we expect, except for the numbers 5 and 6. You may use them to count, but they are also *equal* to each other! This feels bad and it certainly breaks the Peano axioms. In my new system 1 plus 5 and 0 plus 5 are the same, so I can equate 0 to 1. Because 0 and 1 are the basis of binary arithmetic, all numbers can be equated. Numbers now have no guaranteed meaning in my system and, what is worse, since logic uses 1 and 0 to represents true and false, all of logic falls apart as well. Whenever we allow inconsistency into mathematics it rapidly brings the whole pack of cards down.

The example I gave was glaring; an inconsistency right in the middle of the counting numbers! Maybe I was too aggressive and a subtle and less damaging inconsistency might be tolerable. However, *any* inconsistency allows me to make zero equal one somewhere in my system and, therefore, any theorem based on proof by counterexample will be suspect.

There might be systems where inconsistency could be a legitimate part of a mathematical system, but I would always need positive corroboration for each proof. If I tried hard enough, I could always prove something either way. I would need to formulate a new mathematical rule – something like "I will believe short, sensible-looking proofs to be right and circuitous proofs to be wrong." Mathematics would be a bit like a court of law. You would have to weigh up the evidence from a variety of sources and the verdict would be a matter of subjective opinion rather than objective fact. Inconsistency is *very* bad in mathematics.

The Lucas Argument

J.R. Lucas of Oxford University believes Gödel's theorem says something fundamental about the nature of the human mind. In 1959, he wrote a paper, *Minds, Machines and Gödel*, where he argued humans must be able to think outside a fixed set of formal rules. The paper has been causing arguments ever since. Strong AI proponents have a visceral reaction to it. Forty years later, in 1989 Roger Penrose picked up the baton and put the Lucas argument on a stronger theoretical footing. The Lucas-Penrose argument is this:

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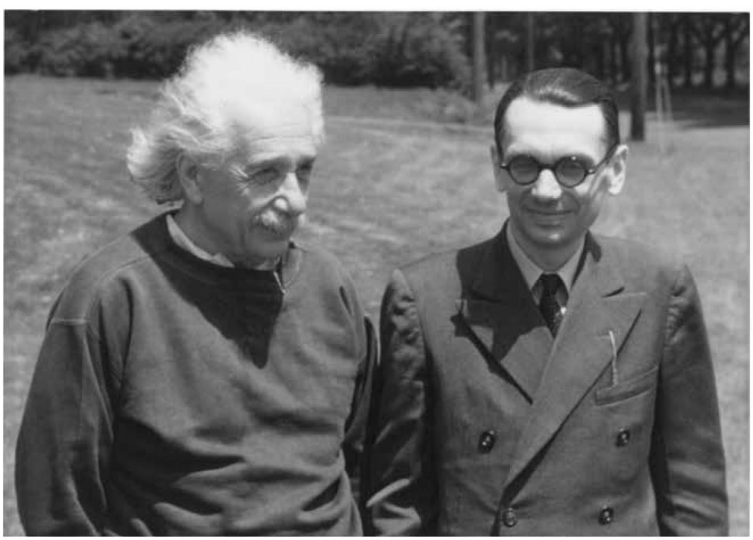
If humans used a formal system to think, they would be limited by the incompleteness theorem and unable to discover new theorems that required them to extend the formal rules. Humans do not appear to have such a limitation and regularly extend their appreciation of mathematics by expanding the rules, and seeing through to the truth.

Many scientists dislike this argument and think it farfetched, saying there is no evidence to show people see past the limitation. Our brains could be following a formal system capable of discovering everything we have discovered to date or, indeed, might encounter in the future. Why should we assume human minds are constrained in the same way as the mathematical systems they discover? There is no evidence to suggest a human *thinking* about Peano arithmetic is running a Peano based model in their head. When Peano discovered his theorem he was certainly extending our mathematical knowledge, but this does not imply he was extending the capability of his brain.

The critics of Lucas and Penrose have one big problem to deal with. The formal system in our head would need to be able to see the truth in everything we could *ever* encounter. But, our formal system appears to be small. As infants, it is almost nonexistent. Where does this enormous system come from? It can't come from our parents because they have the same problem; they were once children. You might argue that the capability of the human brain is huge and we can learn from all the other humans on earth, but let me remind you what Gödel said. However large



Two Giants

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a system you have and however much you extend it, the system will always be incomplete. And we really do mean; however large. Even an infinitely large formal system would be incomplete.

The only way to avoid this problem is with some sort of conspiracy theory where we only come across problems our formal system can already solve. Such a theory is a determined Universe. In a determined Universe, all the mathematical problems we ever solve must be expressed by the formal systems existing in the Universe. We must never encounter a problem where we need to extend the system and break the Gödel limit because we are pre-determined not to do so.

The Inconsistency Defense

An argument put forward by opponents of the Lucas-Penrose position is that humans are inconsistent formal systems. Inconsistent formal systems are not subject to the incompleteness limit. Humans certainly behave inconsistently with remarkable regularity but simply making inconsistent statements is not sufficient to show the underlying formal system is, itself, inconsistent. Inconsistent beliefs can come simply from making mistakes or reading the same story in two different newspapers! We need a fundamentally inconsistent thinking mechanism inside our brains to break the constraint. The very machinery itself would have to be inconsistent. But this is exactly Penrose's point. Constructing a machine capable of reasoning in an inconsistent but useful manner would need exotic technology, some sort of non-deterministic, rationalizing computer. The components to make it could not be computer logic as we know it today. All such logic is entirely computationally deterministic.

Let me see if I can reframe the Lucas argument. Imagine IBM's Watson computer was let loose on mathematical reasoning. Watson could scan every mathematical theorem ever written down. It would know every programming language created. It would have its enormous bank of general knowledge to call upon and it could answer many questions. It would sometimes appear inconsistent because the information it had trawled from the Internet would be wrong. But Watson would still be a consistent formal system and Gödel's theorem says there would be truths Watson could never see. Lucas argues humans can see such truths where a machine cannot, and these truths would allow a human to discover a proof to a mathematical problem that would forever elude Watson.

The Lucas argument runs into a brick wall because it asserts we see truths a machine cannot. For each alleged creative step, his opponents simply assert your brain was already sufficiently powerful to perform

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that creative step. Lucas's argument is largely a philosophical one. Surely all this creativity can't all be pre-coded within the brain. Surely we must be extending our model in order to extend mankind's mathematical model. "Prove it," say the detractor, and he cannot. We need something more practical if we're going to show a difference between humans and machines - something an engineer, or even a physicist, could grasp! That thing is a Turing Machine. We will examine this next.

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Chapter 10

TURING'S MACHINE

Alan Turing

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"A computer would deserve to be called intelligent if it could deceive a human into believing that it was human."

Alan Turing

"The only real valuable thing is intuition."

Albert Einstein

"Mathematical reasoning may be regarded rather schematically as the exercise of a combination of two facilities, which we may call intuition and ingenuity."

Alan Turing

It is 1943 and a small group of Polish mathematicians sit, ears glued to their wireless set, waiting to hear whether the German army will advance on Warsaw. The Polish Intelligence Bureau badly needed to know what the German army was planning and had recruited this group of young mathematicians as code breakers. Up to this point, code-breaking had been the domain of linguists able to see word patterns in apparently random sets of letters. The arrival of electro-mechanical machines made this method redundant, and code-breaking had become the domain of mathematical minds. The British, French, and American intelligence agencies were all hard at work deciphering the German codes, but only the Polish group, motivated by the imminent threat of invasion, had made real progress. The code they were breaking: 'Enigma'.

As with many inventions, Enigma got off to a difficult start. The inventor, Arthur Scherbius, tried to sell it to the army but they rejected it saying it did not provide any real military benefit. Instead, the machine went into service transmitting commercial shipping manifests. However, some senior figures in the German military had not forgotten the lesson of the First World War. During that war, the German army suffered major setbacks because the British broke all their codes early on. With the onset of World War II, Rommel ordered the German Army and Navy to deploy modern coding machines. The previously rejected Enigma was rapidly pressed into service and, all of a sudden, Europe went dark to Allied Intelligence. The man to lead the task of breaking Enigma for the English was Alan Turing.

Alan Turing

Alan Turing was conceived in India but born in London in early 1912. He was precocious from an early age and an extraordinarily determined character. His first day at Public School, Sherborne in Dorset, coincided with the British General Strike of 1926. With no public transport available, the thirteen-year-old Turing cycled the 60 miles to school, staying in a guesthouse on the way and earning a write-up in his local newspaper. Turing went on to study Mathematics at King's College, Cambridge and was made a Fellow at only 22. In 1936 Turing, aged 24, published *On Computable Numbers and their Application to the Entscheidungsproblem*, not a snappy title, but one of the most influential mathematical works of the 20th century. The paper described the new the science of computing and solved Hilbert's 'Entscheidungsproblem', a mathematical puzzle

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simply translated as 'the Decision Problem' – could you decide the truth of a mathematical statement using some sort of automatic computation – an 'algorithm' as we now call it?

It is difficult to imagine, but Turing worked on 'computing' before the invention of the computer. When he talked of computing, he meant the abstract idea of doing something mechanically. The nearest thing he had to a 'computer' at the time was a human mindlessly but methodically calculating something with pencil and paper! The scientific paper he submitted to the London Mathematical Society described both the theoretical basis of computing, and the design of a general-purpose computing machine: the forerunner of all modern computers.

At the time, only a handful people in the world could assess Turing's paper. One of them, Alonzo Church, was based at the Institute of Advanced Mathematics in the USA on the Princeton University campus, next door to the Institute for Advanced Study that housed Einstein. Turing travelled to America in 1937 and completed his doctoral thesis at Princeton. He might have stayed, but Europe was heating up and war seemed inevitable, so Turing returned to England to take up a part-time job in the government code-breaking branch. Here he was able to indulge his passion for hands-on engineering, experimenting with the newly invented valve technologies. When war finally broke out Turing was ordered to report to Bletchley Park, just north of London. This was to be the home of the top-secret British code-breaking group tasked with cracking Enigma. Turing's first task was to debrief the Polish mathematicians and see what they had discovered. The Polish mathematicians had seen there were flaws in Enigma that made it repeat itself. They had made a copy of the machine to test different coding configurations and had been routinely cracking Enigma for 6 years, but the Germans had been getting smarter and it was taking longer and longer to crack the codes. Turing realized he could apply the Polish ideas in a more general way and break the codes on an industrial scale. He was installed at Bletchley Park to lead the project.

Initially he was successful but as the war continued, Enigma developed subtleties making it harder to break. At one point, it was taking a whole month to break a single day's messages. Turing realized the only solution was to use computer technology to fully automate the decryption. He built a computing machine that could simulate thousands of Enigma machines and try out all the possible settings in a short space of time. The machine acquired the nickname 'a bombe', perhaps because of the ominous ticking sound it made as it calculated (or maybe as a reference to the smaller Polish machines).

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Thanks to Turing's insight into coding schemes and the machines he designed, the British were soon able to read almost every coded message the Germans sent during the war, giving the Allies an enormous advantage. The D-Day invasion involved convincing Hitler that the Allies had a huge army of nearly 400,000 men, massed around Dover preparing an attack on Calais head on, with a second army in Scotland poised to attack Norway. In truth, they had only 150,000 men planning an assault on the Normandy Beaches in the South. Just before the landings messages were decoded showing Hitler had fallen for the Allied subterfuge. Even as the Normandy landings began, Hitler still thought this a bluff and kept his 28 divisions at Calais waiting for the imagined attack. Without this intelligence advantage, the Allies would have needed a much larger invasion force, and Churchill believed Turing's work shortened the war by as much as two years.

The cracking of Enigma remained a secret after the war and Turing's story remained untold for many years. When Churchill wrote his history, *The Second World War*, a massive work in six volumes, all sorts of sensitive information featured, but Turing's work was omitted. One sentence hints that Churchill might write something about it in the future, but he never did. Churchill considered the work at Bletchley Park so sensitive he had it put in the highest classification – extending the 30-year secrecy rule. We must presume the decoding schemes were still being deployed during the Cold War. The papers were finally released in 2010.

In one of those sad turns in history Turing was found guilty of gross indecency for homosexuality in 1954, a criminal act at the time, and was prescribed hormone treatment. This affected his mental state and he took his life by eating an apple laced with cyanide. He was eventually honored posthumously as a war hero and one of the most significant thinkers of the 20th Century. A Turing Award is the equivalent of the Nobel Prize for Computing. He was given a royal pardon in 2013.

To see how Turing came up with the idea for the Turing machine and solved the decision problem, we need to get a feel for theoretical mathematics. That might sound a little heavy going but don't worry, I will use a simple piece of mathematics to explain, one we have all played with as children, secret codes.

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Codes

Everyone has played with some sort of secret code as a child – the Aggy Waggy game, passing notes written in invisible ink made from lemon juice, or perhaps a simple cypher. If I want to send you a secret message, I can use a substitution code. Let's see how good a code breaker you are. Can you decode this?

Enigma Machine

Gdkkn Qdzcdq

It's really easy. You might guess the message from the pattern of letters and your knowledge of my writing style. There are a couple of interesting patterns to note: the 3rd and 4th letter of the first word are the same and the first and last letter of the second word are the same. As a test I gave this code to my wife and my eight-year-old daughter to see how long it took them to decode… Less than a minute for my wife – a linguist. We will come back to my daughter shortly!

Roman Emperors used this sort of simple code to secure their messages, but modern codes have to be a great deal more sophisticated. Let us use a progressive cipher where we vary the substitution using a secret word. Take the name of my dog and write it down repeatedly next to the letters of the message you want to keep secret. Now translate all the letters in the message and the code into numbers 'a' = 1, 'b' = 2 and so on. Then add the letters of my dog's name to the letters of the message one at a time. If I get to 26 ('z') just wrap around to 'a' and carry on. This is called modulo arithmetic. This coding scheme will translate 'l' to 'a' the first time but 'l' to 'c' the second making it much harder for a linguist to see any pattern.

hello reader can you read this code
georgegeorgegeorgegeorgegeorgegeorge

Gives

ojacveyjpvlwghpegcvzoilfkehzpxghcvle

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The advantage of this cipher is that I can easily remember the name George. I don't need to write it down. And the circular application makes the message sufficiently obscure you can't easily work it out…

Is this, therefore, a good code?

No.

This cipher is easy to break. Once you have guessed that I have applied a repeated short code word, you can write out ALL the possibilities and decrypt my message! This may be tedious, but if you are fighting a war and your life depends on it, you can employ a thousand people to write them all out. The British government employed 10,000 people at Bletchley Park, many of them doing exactly this. You might think that applying ALL the possibilities is too time consuming in practice but there are many shortcuts. If I suspect the message contains the name of a German town all I need do is try keys until I find a German town somewhere in the message then work my way outwards from there. Or perhaps I suspect the key is something easy to remember like the name of the Commandant's dog. I can try ALL German dog names until I get lucky. If I've 10,000 people working for me this is easy.

The Enigma machine and the coding process set up to operate it was designed to remove these loopholes. For a start, the keys were all random numbers taken from a code book – no dog names allowed – and the machine took the idea of a simple progressive cipher and made it *much* more complex.

Imagine I took my GeorgeGeorgeGeorge pattern but then every 3rd character added one, every 14th character subtracted 15 and every 40th character added the 3rd letter of the First Mate's mother's maiden name. Now this would be a VERY hard code to break. I would need a machine to code messages because if I tried to do it by hand I would make so many mistakes that the messages I send would be unintelligible. The Enigma machine made these coding schemes a practical possibility. But, although Enigma is hard to break it is not impossible with enough computing power. Is there any code that is impossible to break?

An Unbreakable code

Is there a way of coding a message so you can never break it?

The answer is there are two ways to code a message so it is PERFECTLY safe. The first is to use a one-time pad and the second is quantum cryptography.

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One perfect way to encode a message is to use a one-time pad. On a sheet of paper I write a completely random set of numbers or letters – since we are going to translate numbers to letters it does not matter which. I make a copy and give it to a person I later want to send a coded message. Because I will only use these two paired sheets once it helps to make a few of them – a pad in fact. By convention, we refer to a single sheet or a whole book as a one-time pad code. Here is the one-time pad I created earlier. It is just a random sequence of letters and spaces.

kaleygnqaloiuebldlan dlkawoqyevbax gmlsosuebal

To code a message, I substitute numbers for letters as with the progressive cypher earlier again using modulo arithmetic to wrap around if I reach the letter 'z'. I have applied my one-time pad to the hello reader message below to get 'sfacngfvbpta'.

hello reader
sfacngfvbpta

This code is unbreakable – almost! Notice there are very few clues for anyone wanting to decode it without holding a copy of the pad. Spaces do not necessarily indicate breaks between words, and letter patterns are absent. It has only one flaw. The total number of characters and spaces could have some meaning. This is a problem because if I routinely communicated bombing targets and my message was "Bomb Bath". You could figure out the sender was not going to bomb Bristol if the message were shorter than 11 letters and spaces. To avoid this problem, messages are extended with nonsense at beginning and end to make sure no information can be gleaned from the length. The convention is to code messages to the full length of the pad. You must never reuse a pad. Each time you code a message, rip off that page rather like a calendar. Destroy it and use the next page for the next message. At the other end, the recipient uses his copy of the pad to run the process in reverse. Decode the message by swapping each letter according to the modulo method, rip the page from the pad, and burn it. Because each key is only used once you can't use any sort of statistical method to work out the message, making the one-time pad perfectly secure. Claude Shannon proved this in 1945 while working for Bell Corporation but, due to wartime secrecy, his proof was not published until 1948.

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The Perfect Code

The proof that a one-time pad is perfectly secret is straightforward. Imagine I take a coin and flip it 1000 times. I'll write down some of the results as follows:

HHTHHHTTHTTTHTTTTTHTH...

I give you a copy of my results and keep one for myself. Now we each have the same random set of Heads and Tails recorded on a piece of paper. I can convert any message from letters to binary numbers: 'a' = 00000001, 'b' = 00000010, 'c' = 00000011 and so on. If you are not familiar with binary just assume I have a code where we only ever use combinations of 0s or 1s. To encrypt the message we flip each bit – 0 goes to 1 or 1 goes to 0 – using my random list of heads and tails according to the following rule: If I have a head flip the bit, otherwise leave it the same. I now have a randomized message, and it really is truly random. To convince yourself, imagine answering the question, do you like coffee or tea? Think of your answer and flip a coin. If the coin lands heads change your answer otherwise leave it the same. Now write your answer down. Try it out a few times. Do you see you end up with a totally random set of decisions – tea, coffee, coffee, tea, tea, tea. If you don't record the coin toss there is no way to determine your true answer.

Similarly, the message I encoded above now looks like a completely random stream of 1s and 0s and the only person who can decode it is the party with the other record of the coin tosses. Apply this to the message and, as if by magic, the message reappears. Any other random sequence will yield gibberish. It has to be the SAME random sequence I used in the first place.

Mathematically, the proof involves working out that the probability of getting the right answer by applying a random sequence is 1 in 2^n and the probability I could guess the answer is also 1 in 2^n? The same! So the chance of decrypting the message knowing the encryption method is the same as simply guessing the message and getting lucky. Therefore, the message is perfectly encrypted.

Quantum Cryptography

It turns out there is one other perfect encryption method that involves thinking about the nature of secrets. Normally we consider the primary problem with sending a secret message is coding it so that it can't be read

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by anyone but the intended recipient. However, wouldn't it be equally valuable to know if someone other than the recipient had intercepted and read the message? This is the trick quantum cryptography gives us.

Taking a measurement with a quantum device disturbs the system so measurements can be taken only once with the same results. By the same logic, I could send you a message and if someone else has read it in the meantime, you will know. I could arrange to meet with you in Berlin and if you detect the message has been intercepted, you could simply not show up.

I could use this same technique to send you a one-time pad. If you receive it without it being overheard, I could then safely send you an encrypted message. In 2007, this technique was used to transmit the results of a Swiss election from the polling booths to the central counting center.

Enigma

World War II accelerated the evolution of encryption from simple substitutions a human could perform to complex ciphers only a machine could calculate. You might wonder why everyone does not use a one-time-pad since it is a perfect code. The problem is distributing and maintaining the pads while keeping them secret. My daughter cracked my earlier code because she knows my laptop password, broke in, and read the answer. That's the problem with codes – security. The pads could be sent out in sealed envelopes but it would be easy to intercept an envelope, copy the pad and reseal it. You would then have a perfect and undetectable way to break the code. Also, if I were an Admiral wanting to communicate with my fleet of submarines I would need a huge pad – one page for every message I want to send – and either a pad for each submarine or one pad for all submarines. If I use only one pad, then I cannot talk to a submarine privately, and if any pad were lost *all* security would be breached. One-time-pads were used by both sides during World War Two, and often printed on nitrocellulose – a chemical similar to the explosive nitroglycerine. This allowed users to burn the codebooks quickly if an enemy threatened to capture them.

Both the Americans and British captured Enigma machines and codebooks during the war. A Navy Enigma machine was a sought-after prize, as it was more complex than the Army version, with extra dials and plug settings. To crack the more sophisticated codes Bletchley Park

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needed to get hold of Enigma machines, ideally without the Germans' knowledge. The film *U-571* merges two such capture stories into one, taking a few dramatic liberties along the way, but it's well worth watching.

Even with a captured machine, the codes were hard to break. You needed a starting point – a crib to give you a clue what the machine settings were. Helpfully, the German Army often began their messages with a weather report. Everyone knows the German word for weather – 'Wetter'. Decode the first 20 letters of a message until you found 'Wetter' and the message is unlocked. The German Navy, however, was less chatty and avoided obvious words in their messages. One way the Allies could find a crib was to blow something up. They would sail to some point in the Atlantic, fill an old boat with oil drums, and set it alight. The German Navy would get wind of this and go to investigate. The first thing they would do is to radio a message back to base with the coordinates of the wreckage, which, of course, the British already knew. This gave the British a crib, and once they were in, they could decode messages for several days in a row because the Enigma machines often cycled through a repeating pattern.

Throughout the War, the German military never suspected the British had cracked their codes and thought they must have traitors giving away their secrets. The Enigma machine was an elegant compromise between a truly unbreakable code and a simple cipher. Unfortunately for the Germans, Turing was on the side of the Allies.

In the 1930s almost all mathematics, accounting, and code-breaking were performed by humans using pencil and paper. It was the science behind this process Turing sought to understand. We'll take a step back in time again to 1935 and Turing's discovery of a solution to the Decision Problem – *the Entscheidungsproblem*.

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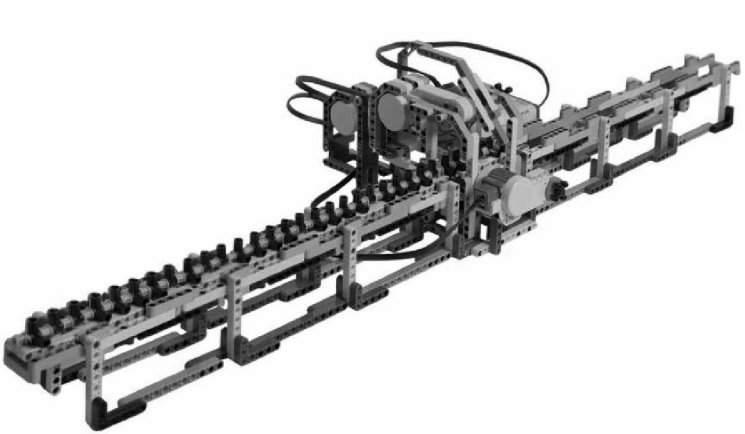

Lego Turing Machine

"Machines take me by surprise with great frequency."

Alan Turing

The Machine

Turing probably learned of *the Entscheidungsproblem* in a lecture given at Cambridge University by Max Newman. Newman described a new proof by Gödel showing mathematics was incomplete. The proof solved the completeness and consistency problems by turning mathematical statements into numbers and showing you could generate a logical paradox if you tried to argue for completeness and consistency at the same time. Thus, of the three original Hilbert problems, completeness, consistency and decidability, only decidability remained unanswered.

Turing spent all of 1935 and much of 1936 thinking about this question: Is mathematics intuitive, or could a machine decide mathematical questions automatically? Eventually, cycling through the Cambridge countryside one day, he stopped to rest in a field near Grantchester and in a flash of inspiration envisioned his mathematical machine. The machine was entirely imaginary but made as if from mechanical parts common in the 1930s.

The idea was to reduce the process of computing with pen and paper to its most basic level. Turing hit upon the idea of using a long ribbon of paper tape similar to the ones used in telegraph machines. A paper tape is simpler than rectangular paper as it can be handled mathematically as a single sequence of numbers – we don't have to worry about turning the page or working in two dimensions. If you are worried that a tape is less powerful than a sheet of paper remember Cantor's theorem: an infinite plane is the same as an infinite line. The use of a tape massively simplified the mathematics, and subsequently many early computers used tapes, as they were easy to handle in practice as well as in theory.

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The eye, hand and pencil of a human mathematician was modeled as the read-write head of a teletype. It allowed the machine to read input from the tape and write information back so as to keeping track of intermediate calculations or provide the final output. The operation of the machine was straightforward. At each moment in time the machine could read a symbol on the tape, move the tape forward or backwards, and write or erase a symbol. That's all he needed to model a human doing something like long multiplication. Turing argued his model was exactly analogous to a human performing a computation.

Turing's imaginary machine was now able to perform computations just like a human. You could write down the rules for a given procedure and the machine could, for example, do long multiplication. At each step of the calculation, the computer would examine the state machine, look up the state in the instruction book and put the machine into its new state. If you recall Searle's Chinese Room, this is the same process the man in the room followed: get a symbol, look it up in a book, and reply with the corresponding symbol.

Universal Turing Machine

We have missed one important step from our explanation of the modern computer: the ability to run programs. Nowadays, we take for granted you can download a program from the Internet or buy one from a shop. In the 1930s adapting a single machine to multiple purposes was a radical idea. Machines were built to do one thing, and one thing only, and there was no concept of a general-purpose machine. Nowadays this is hard to comprehend, but there is a similar revolution going on in manufacturing today with the widespread adoption of 3D printing. Today most factories use tools – lathes, drills and saws – to fashion objects. Each machine does a specific job and is not 'general purpose'. But innovative new machines can now be purchased relatively inexpensively called 3D fabricators, which print entire objects. The same happened for electronic logic in Turing's time.

Before computers, logical tasks were performed by banks of relays. How these banks work can be illustrated by the workings of an old-fashioned elevator. If you pressed a button to call an elevator, you closed a switch coupled to a relay in the basement sending power to the car. Another switch was tripped automatically when the elevator reached the desired floor. All the functioning of the elevator system was fixed. Once you pressed a button to go up you could not change your mind and press

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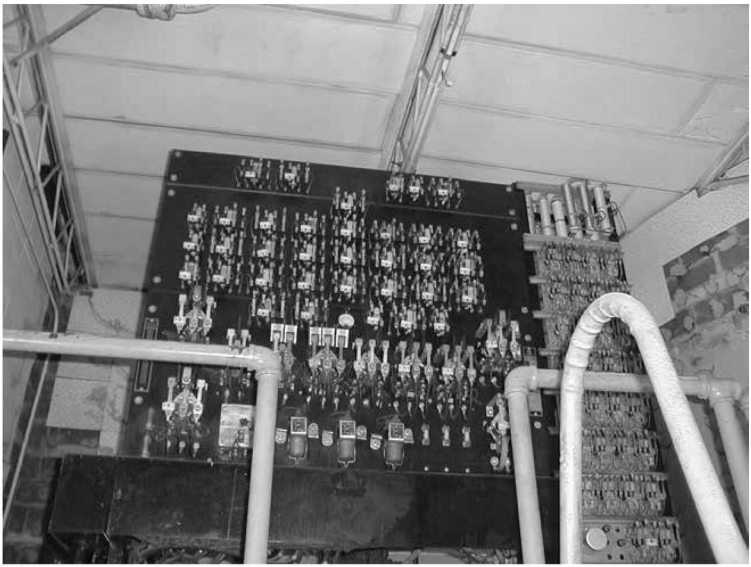

Old Fashioned Relay Mechanism

the button to go down. That logic did not exist in the relay banks. If you wanted to improve the logic of the elevator you would need to rip out all the relays and rewire everything from scratch.

Turing's first imaginary machine was set up in the same way. It had a fixed set of hard-wired logic, a rule book. In order to perform different tasks – say addition or multiplication you had to use a different rule book. His revolutionary idea was to write a rule book that told the machine to read a soft-wired set of instructions from the tape and execute those instead. He called this a Universal machine since it could perform *any* procedure written on the tape. Today we call this software. It is fair to say Turing was not the first to use this idea. Charles Babbage's analytical engine could read instructions from cards and execute different procedures, but Turing thought through all the ramifications of the idea and made it general purpose, giving us the modern science of computing. It is easy to build a real Turing machine, but by today's standards it is a little clumsy; a team in Denmark has built one using Lego. You can see a link on my website.

Very soon after Turing's paper was published, a number of people proposed better practical implementations. In 1943, John von Neumann of Princeton University created the architecture for ENIAC, the first stored program computer, developed for the United States Army's Ballistic

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3D Printing Machine

Research Laboratory. The laptop I am writing on uses the von Neumann architecture, and most modern computers evolved from it. By contrast, mobile phones are descended from the Harvard architecture developed by IBM and first supplied to Harvard University in 1944, hence its name. The distinction in architectures has blurred over the years. The world supports two main computer chip technologies, one built for desktop and laptop computers, designed by Intel in Santa Clara, California, and the other, designed for mobile devices by ARM, in Cambridge, England. All these computers can, in principle, run any piece of software.

Programs

Software is just a series of numbers. When you click an icon on your desktop, the computer reads the number and interprets it as a series of instructions. There is a decoder inside the computer that knows the number '1' means add the next two digits and the number 5493 means display them on screen and so on. On my computer the operating system, Apple's OSX, takes the number, decodes it and passes it to the CPU for

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execution. You might ask what runs the operating system and that is a smaller program called the BIOS. What runs BIOS? An even smaller program called the Bootstrap. Once all this is up and running you have a working computer, which can run any program you throw at it.

The problem with programs is they tend to crash – usually at the most inconvenient times. It is often not clear whether a program has truly crashed. It might be stuck in an infinite loop, or it could be calculating the answer to a complex question, such as the answer to life, the Universe, and everything. How would we know? If only I had waited a little longer before rebooting, the program would have run to its end and given me the answer to Douglas Adams' question.

It would be very useful, and save a great deal of time, if I had a way of telling whether a program will ever stop. An elegant solution would be to have a second program called 'Halt', which would test the program and output 'will halt' or 'will crash' as appropriate. It turns out this program would be more than just useful. It could be used as an oracle, capable of answering almost any question imaginable.

I could, for example, write a program that says: for every index in Fermat's puzzle try every number and halt if you find a solution greater than 2. Now if I run my halt program on this program and it states 'will crash', I will have solved Fermat's Last Theorem! Do you see why?

If we give 'Halt' an input: a program we are interested in, along with some data, it will tell us if the program finds an answer. If I am trying to solve Fermat's Last Theorem, we will ask it to try every possible index for the equation $3^x+4^x=5^x$ and halt when it finds a true result greater than 2. If the halt program says yes and halts, you can trace through the program and work out how it did it. The theory would be proved. If the program says no, the theory is disproved. This gives us a way to discover proofs of many mathematical theorems.

I could try almost any puzzle using a program with this form. All I need do is put a problem in the following decision format: *try all possible options, and then stop and ring a bell if a solution is found.* The Halt program would then give the result leading to untold riches, winning all the remaining Clay Mathematics prizes at the very least and earning me $6m.

Does such a magical program exist? The answer, sadly, is no. There is no Halt program and the final part of Turing's paper proved there can never be.

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The Proof

Let's write a list of all the possible programs my laptop could ever run. A comprehensive way to do this is to start at one and try every number.As I count up I am simply generating numbers, for example, 5,433,232, then turning each number into a program file and running it. For a bit of fun, I created a couple and tried them out on my laptop. They did nothing, so it was not very edifying. Most numbers are just junk because programs have to be in the right format for the computer you are working on. It's just like words. If you randomly take a handful of scrabble tiles out of a bag, most of the time you will have nonsense, but every now and they you will have an actual word. Be careful with this; you could accidentally write, "delete every item on my hard disk." Of course, the probability is astronomically low, but Murphy's Law says it will happen, so back up your data!

As you count up, you will generate every possible program along the way. A mathematician would say programs are recursively enumerable. The word recursive means there is an algorithm and enumerable means to count. Therefore, there is a counting algorithm that would run every imaginable program. Here is a list of them, or at least a some of the highlights:

0 (probably doesn't run)
1 (ditto)
00 (ditto)
01 (ditto)
011001001001000100 (makes the computer beep once)
… (from here on I'll give the program names since the numbers are too large to print)
Does Nothing (there are many of these)
Is Gibberish (there are an infinite number of these)
Junk (an infinite number of these)
Print Something (again an infinite number of these)
More Gibberish
Excel
Word
PowerPoint
Mathematica...
Fermat's Last Theorem enumerator (runs for ever)
A nonworking version of the Halting Program
A nonworking version of the Crashing Program
Really big programs that don't fit on my hard drive

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and so on.

You can see that every program imaginable is generated in our list. If you are wondering which version of Word or Excel, the answer is *every* version and every bug ridden unreleased version as well. We are enumerating every program that could ever be run in the known universe!

Perhaps you can see a problem looming. I can pose any mathematical puzzle in a clever way so that a program only stops if there is a solution. I am about to list every possible program that could ever be created. If halt exists this will automatically prove every mathematical theorem imaginable.

Let us see if this is so.

For our thought experiment, we will assume every program takes an input. Historical convention in computing means this is generally the case. If you type a program into the command line of a computer with some words listed afterwards, the computer will usually run the program with the words as input. For example, if you type, "Print 'Hello World'", most computers will print 'Hello World'.

We now imagine there is a Halt program that can run on an infinity of inputs. Will it work for every input? We are looking for a paradox caused by the existence of the Halt program. If Halt causes a paradox then Halt cannot exist.

Here goes...

If there is a Halt program, we can write a Crash program. That's a program that goes into an infinite loop if it detects a program will halt. Now what happens when we feed Crash into itself? Does Crash halt if it runs with the input Crash?

This creates a paradox; there is no solution which makes sense. It's similar to the Barber Paradox of earlier. Since a paradox is created there must be a fault in our original theory. The error is the existence of Crash. Since Crash cannot exist and it was created as the logical opposite of Halt, Halt cannot exist either. QED. There is no general program that will tell if another program will halt because such a program could not run with the negative of itself as input.

This places a limit on the power of computers to automatically solve problems. There is certainly no general purpose algorithm which will solve every problem. Slightly more subtly there is no general purpose program that is guaranteed to solve one arbitrary problem.

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If there were, you could just write a program to sequentially present every problem to the arbitrary problem solver and you would have solved everything.

This presents us with a puzzle. A huge software industry has grown up based on Turing's ideas, employing tens of millions of people worldwide. This industry regularly solves all manner of problems. The proof from Turing's original 1936 paper suggests there should be quite strict limits on the power of computers. In the next chapter, we will examine this industry and take a look at Turing's theorem from a modern view point. The chapter can be read as a stand alone article but was originally written as an integral part of this book.

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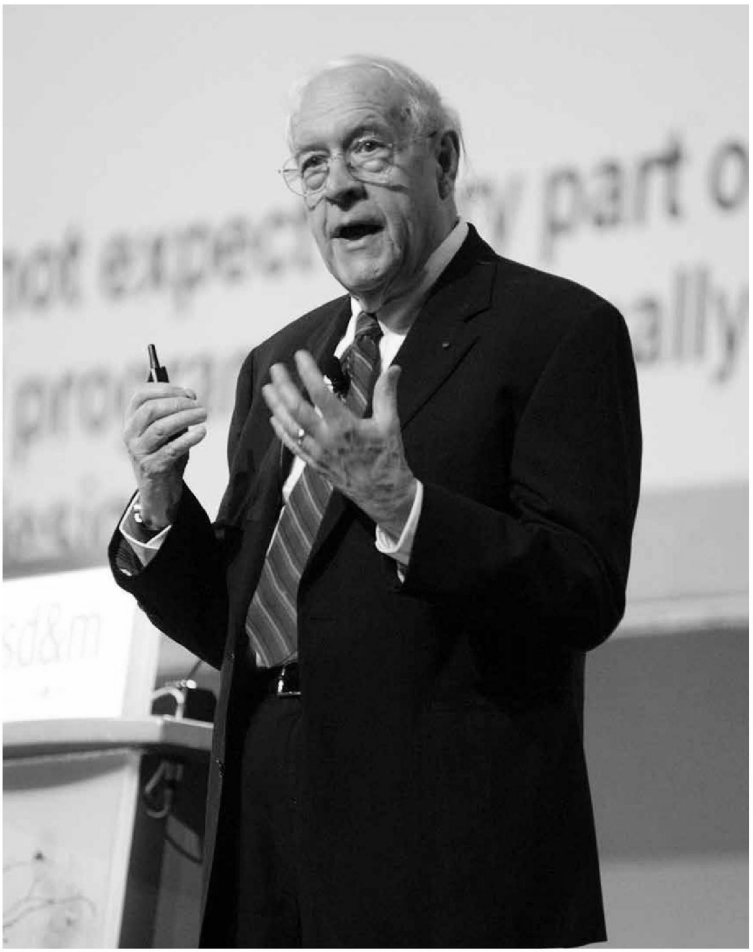
Chapter 11

SOFTWARE



Fred Brooks

Medieval Block Print from 'No Silver Bullet'

"The bearing of a child takes nine months, no matter how many women are assigned."

Fred Brooks

"Adding manpower to a late software project makes it later."

Brooks' Law

In *No Silver Bullet – Essence and Accidents of Software Engineering*, Fred Brooks explains why writing software is hard, and why machines are not going to do it for us anytime soon. The original article appeared in the proceedings of the Tenth World Software Conference. It was subsequently expanded into the, now famous, book, *The Mythical Man Month*.

Brooks believed solving real world problems involves understanding the essential complexity of life. 'Accidental Complexity' – the simple type – is the time-consuming part of writing software, for example, listing all 220 countries of the world in a website, or making sure all the buttons in an interface line up correctly. These tasks are tedious – you have to look up all the countries in Wikipedia and make decisions, such as whether the United Kingdom will be denoted 'UK' or 'GB'. They don't need any real ingenuity. 'Essential Complexity' is altogether different. It involves understanding the world and setting out the rules in meticulous detail. Brooks argued essential complexity is not susceptible to being sped up by machine processes. Navigating these architectural decisions cannot be automated. He gives us an analogy by comparing writing software to building a house.

When you build a house, an architect designs it, an engineer makes the calculations to ensure it is safe, and a construction firm builds it. The construction process dominates the cost and time. In software projects, an engineer writes a program that precisely defines the design and the construction and calculation is done by a compiler – software that takes the design and makes it machine-readable. Compilers operate in a fraction of a second. Making software is, therefore, dominated by the design time, and design is all about capturing the essential complexity of a task.

This chapter will try to show where essential complexity comes from, why computers can't tackle this sort of complexity and, therefore, why they can't write software. Good news for programmers as this means job security!

For a more thorough treatment of the mathematics read my paper *The Free Will Universe* at www.jamestagg.com/freewillpaper.

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    <meta http-equiv="Content-Type" content="text/html; charset=UTF-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0">

    <title>James Tagg | Invention, Physics and Farming</title>
    <link rel="profile" href="http://gmpg.org/xfn/11" />
    <link rel="pingback" href="http://jamestagg.com/xmlrpc.php" />

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type="text/javascript"></script>
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                }
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/* ]]> */
```

James Tagg's Home Page

"Computers are stupid. They can only give you answers."

Pablo Picasso

"Software is like sex: it's better when it's free."

Linus Torvalds

Silver Bullets Can't be Fired

Human brains are wonderfully creative things. We can compose music, play golf, write novels, and turn our hands to all manner of problems. Many people use their brains to write software. In our modern-day lives we use software all the time: when we access the web, type on a word processor or play a computer game. Software also inhabits many apparently dumb devices. Modern cars contain dozens of computers quietly working away; providing entertainment and navigation, controlling the engine, and helping the car brake safely. In my living room I count over a hundred computers. Many are tiny, like the one in my TV remote control, while others are hidden as parts of larger machines. The laptop on which I write has over twenty computers inside it, besides the main Intel processor.

One thing all these computers have in common is that a human being sat for many hours writing their software. Software is formal logic written in something resembling English.

If I go to my ATM and try to withdraw cash, a programmer will have written out the logic for the transaction as a set of rules.

When I put my bankcard in the slot, and type in my PIN, a line of software will ask: If the bank balance of 'James Tagg' is less than twenty dollars and I have pressed 'withdraw' for an amount in excess of twenty dollars, then display, "We are sorry we cannot process the transaction at this time." and return the card. There seems to be an unwritten rule that the things a computer says should be accurate but unhelpful!

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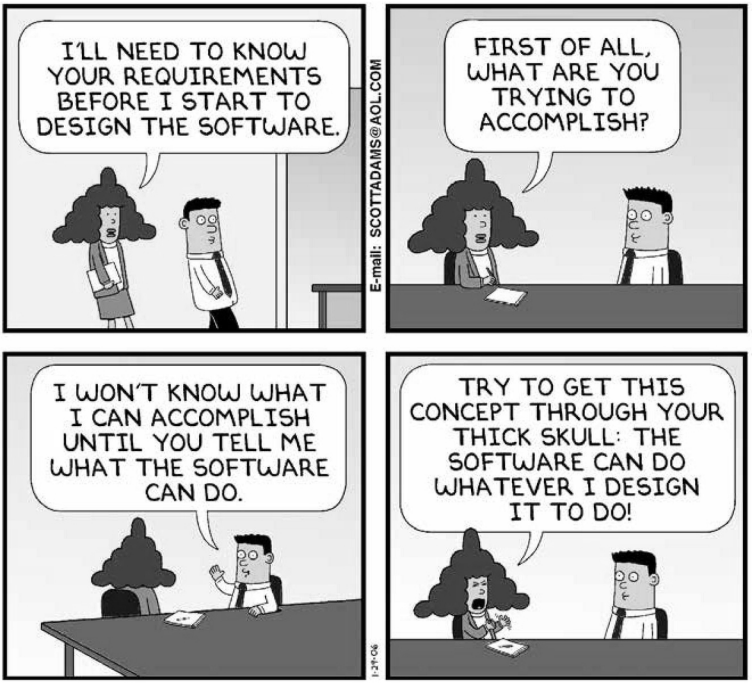

Alice, Ted and Software Specification

It would have been much more helpful if the computer had said, "You do not have enough balance in your account." And, it would have been more helpful still if it had asked whether I needed a temporary overdraft. However, such a feature needs many more lines of software and this is time-consuming to write.

Software takes time and is expensive, because it has to be written in a general-purpose way. Any name could substitute for James Tagg, and any amount could be used. After all, it would be useless if an ATM machine could only give out $20 to one person. The generalization of software makes use of variables instead of fixed values and this renders it hard to understand. Wherever we meet an idea that needs to be generalized, a letter must be used instead of a fixed value. Computer programs tend to look like this: if 'a' wants to do 'b' with 'c' then allow it only if 'd' is greater than 'c'. The software programmer has to keep track of all the possible values that could be inserted into each of the variables and make sure each and every combination would make sense. My ATM scenario gets complex quickly. It needs to be able to answer a range of questions for all the bank's customers, deal with any amount of

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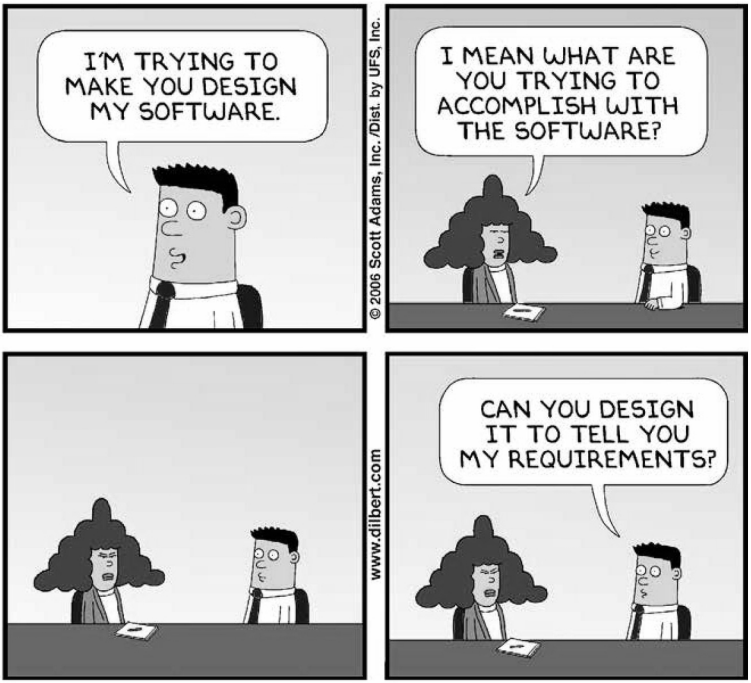

money and handle security when communicating with foreign banks is necessary. A human being must write lines of code for all the rules and every exception, making provision for any gibberish that might be typed in by the customer.

Many people ask, "Wouldn't it be great if my computer could write software for me? Humans could sit back and put their feet up." While most people don't actually believe this could happen, they will often ask why we can't specify software exactly and use unskilled people to write it. Both proposals fundamentally misunderstand the nature of writing software.

What do Programmers Do?

A human software programmer can write up to 1000 lines of code per day. At the beginning of a project, when the work is unconstrained, programmers write fast. Things slow down once programmers encounter the enemy: the real world. By the time the code is complete and selling in shops, the productivity of a programmer can be as low as one line of code per day. This is staggeringly low and luckily only applies to big

commercial software, equating to about 10 words per day. A good typist types at 80 words per minute and most programmers are reasonable typists. So software writers in a big project spend only a minute or so per day in the act of writing. The rest is taken up by meetings, process discussions, email, reporting and so on. In projects that avoid much of this administrative overhead, good software programmers reach a long-run average of about 225 lines per day. This has been the level of productivity on the products I have developed in the past. These projects were lucky. They had a single team on the task from beginning to end and, in general, the projects took few wrong turns. Still these programmers were spending only 10-20 minutes of each day on actual programming. What were they doing the rest of the time?

In the early days of programming you might have a great idea, but the process of turning this idea into software was immensely long-winded. I learned to program at Manchester University in the 1980s. The enormous machines in the basement of the computer building provided heat for both our building and the mathematics tower next door. We were not permitted to play with these basement monsters but were 'privileged' to submit instructions to a mini computer in the undergraduate section – a PDP11-34.

For those of you not acquainted with computers I can tell you the process of writing software in the 1980s was immensely tedious. To add two numbers and display them on a screen took a month of lab time, using detailed instructions written in machine code. Everything was manual, including writing your code out in pencil on special paper with little numbered squares and then giving it to someone to type in overnight! You would return the next day to discover whether you had a usable program or a something riddled with errors. If you found an error, it would require editing. This was nothing like using a modern word processor. The online editors of the day were the ultimate in annoying software. If you misspelled a word, you would need to count up the letters and spaces manually on a printout and enter a command – replace letter 27 of line 40 with the character 'r'. Each and every typo would take five minutes to correct. I managed to finish the simple program required for course credit – I think it displayed an eight-digit decimal number – and ran for the hills. In my second year I bought a PC and decamped to the physics department next door where I remained for the rest of my undergraduate life.

The PC revolution provided programmers with a new and intuitive software creation environment where almost all the tedium was removed. A wealth of tools for creating software was pioneered by Bill Gates of

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Microsoft and Philip Kahn of Borland, along with intuitive applications such as the spreadsheet invented by Dan Bricklin and Bob Frankston and made popular by Lotus Corporation. Today all computers have elegant WYSIWYG, 'What You See Is What You Get' interfaces, where you drag and drop elements into place on the screen. Over the last 25 years writing software has sped up and stopped being tedious – becoming almost a joy!

In *No Silver Bullet*, Brooks explains that writing software can't be accelerated any further because all the tedious mechanical tasks have already been removed. Remember his analogy: Writing software is like building a house, but with some important differences. With a house, an architect handles the design and then turns over construction to a building company. Construction takes an appreciable time, more time than the design and quite a bit more effort. But in software the construction is totally automated. When we complete the design for a piece of software we press compile on the computer and the software is built and tested automatically in a matter of seconds. Speeding this process up any further would make only a tiny improvement in the overall software creation time, since the process is already 99% design and 1% building. For the most part, the creative process of writing software cannot be improved through mechanical means.

This is not always the case. I recently upgraded the machines for some developers I work with. We added solid state hard drives. Compiling a program now takes only 10 seconds, compared with 6 minutes before. Because programmers nowadays tend to compile their programs very regularly we estimate this saves them as much as an hour a day. This is the only real innovation I have seen in the build phase of software in the last 5 years, and it's arguably not an innovation at all. We just forgot to keep on top of the build time and allowed it to get out of hand.

You might argue some counter examples. Modern software design suites let you drag and drop things on the screen to make applications or build a website. Two hundred million people have managed to put together WordPress websites using this technique. These are mechanical procedures for solving a programming task and seem to contradict my argument. They allow us to lay out graphics, press a button and turn the design into software. But they perform very simple tasks. The computer simply notes the coordinates of each box on the screen and places those numbers into a file. The process is entirely mechanical and could be performed by a clerk with no programming knowledge following a set of rules. The computer just does it faster. I did the clever work; I had the

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idea for the software, I came up with the idea for the interface, I decided where to place the boxes, and I chose all the colors, fonts and graphics. I did all the creative bits!

So, now we know what programmers do all day. They create!

Origins of Software

Alan Turing first described the modern day computer in a paper presented to the London Mathematical Society in 1936. He was not trying to invent the computer. That was a by-product. He was trying to solve a puzzle that had been troubling mathematicians for 30 years: *The Decision Problem*.

David Hilbert set out the challenge during a public lecture to the French Academy of Science in 1901, marking the turn of the century. Rather than give a boring lecture extolling the virtues of scientists, he decided to give his audience a list of all the puzzles mathematicians were stumped on.

Rather like the XPRIZE of today, he presented the problems as a series of challenges. Sadly for the mathematicians of his time, there were no million dollar prizes on offer, just a moment of fame and the adulation of their colleagues. Each challenge was given a number. The list included many famous puzzles; the Riemann Hypothesis, the puzzle of Diophantine Equations and the Navier Stokes Hypothesis, to name only three. A group of these questions were to coalesce into what we now know as the Decision Problem.

The Decision Problem is very important to computer science because it asks whether an algorithm can be written to automatically discover other algorithms. Since all software is itself algorithmic you could rephrase the question: Can software write software? This might seem esoteric. But, if you are a computer scientist, it is an important question. If we could solve all mathematical problems automatically we would not need mathematicians anymore. And, since programs are applied mathematics, the same goes for computer programmers.

Before you breathe a sigh of relief because you are neither a mathematician nor a computer scientist, you should remember it is possible to describe all knowledge using numbers. That's what your iPhone does when it stores music. If everything can be represented by numbers, then a fast-enough computer could use an algorithm to create *everything*! You really could set Douglas Adams' *Ultimate Question of Life the Universe and Everything* before a computer and it would come up with the answer – presumably extrapolating the existence of rice pudding and income tax along the way.

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Algorithms

Back in the 1930s no mechanical system could perform a calculation with any speed. People still used pencil and paper for most things; the newly-invented mechanical cash registers were slow and could perform only one calculation for each crank of the handle. If you wanted to calculate something complex, you had to employ a *computer*: a person who could do mental arithmetic enormously fast. Richard Feynman's first job was computing for the Manhattan Project. The question was: Could a computer, either mechanical or human, blindly follow known rules to decide all mathematical questions? Hilbert's 10th Problem asked this question of a particular type of mathematical expression – called a Diophantine equation.

Hilbert's 10th Problem

> *"Given a Diophantine equation with any number of unknown quantities, devise a finite process to determine whether the equation is solvable in rational integers."*
>
> David Hilbert

Diophantus lived in ancient Persia – now Iran. His son died young and Diophantus was so consumed by grief he retreated into mathematics. He left us seven books of mathematical puzzles – some he devised himself and some of them taken from antiquity. The puzzles look deceptively simple and are all based on equations using whole numbers. His most famous puzzle is set in a poem which tells how old Diophantus was when he died. Can you solve it?

> *"Here lies Diophantus,' the wonder behold. Through art algebraic, the stone tells how old: 'God gave him his boyhood one-sixth of his life, One twelfth more as youth while whiskers grew rife; And then yet one-seventh ere marriage begun; In five years there came a bouncing new son. Alas, the dear child of master and sage, after attaining half the measure of his father's age, life chill fate took him. After consoling his fate by the science of numbers for four years, he ended his life."*

Diophantine puzzles look straightforward. Hilbert asked if these problems could be solved by a mechanical procedure, in modern terms, by an algorithm. To show you what is meant by this, allow me to take you

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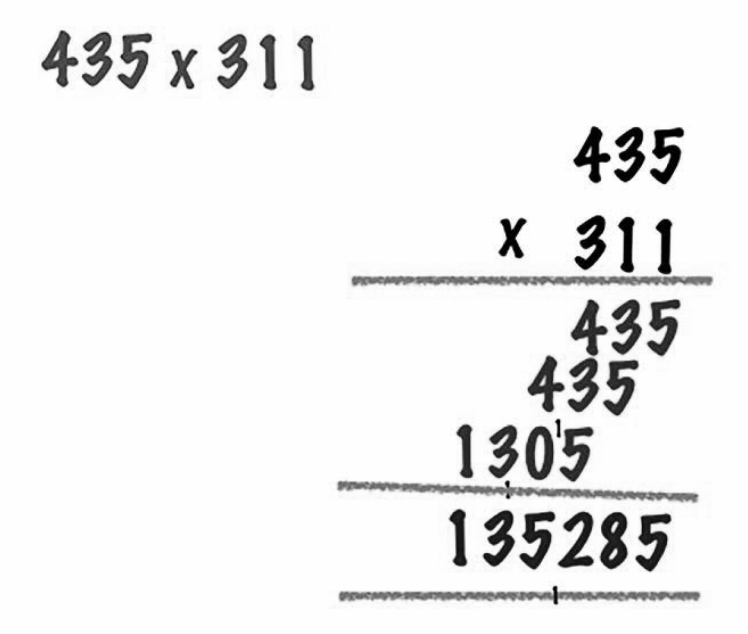

Long Multiplication

back to your childhood. Do you recall being taught long multiplication at school? Take a look at the next illustration and it will all come flooding back. Once you learn the process of long multiplication you can follow the rules and get the right answer for any similar problem every time. To do this, you lay out the calculation in a particular format and apply the logic. Multiply each number by a single digit of the other number and then add the results together.

Diophantine problems are a little more complex than long multiplication and some of them are a bit abstruse. But there is one *very* famous Diophantine problem we can all recite. "The square on the hypotenuse is equal to the sum of the squares of the other two sides." The equation for a Pythagorean triangle.

The theorem applies to right-angled triangles and there are sixteen whole number solutions, known as Pythagorean triples; three, four, five; is one example.

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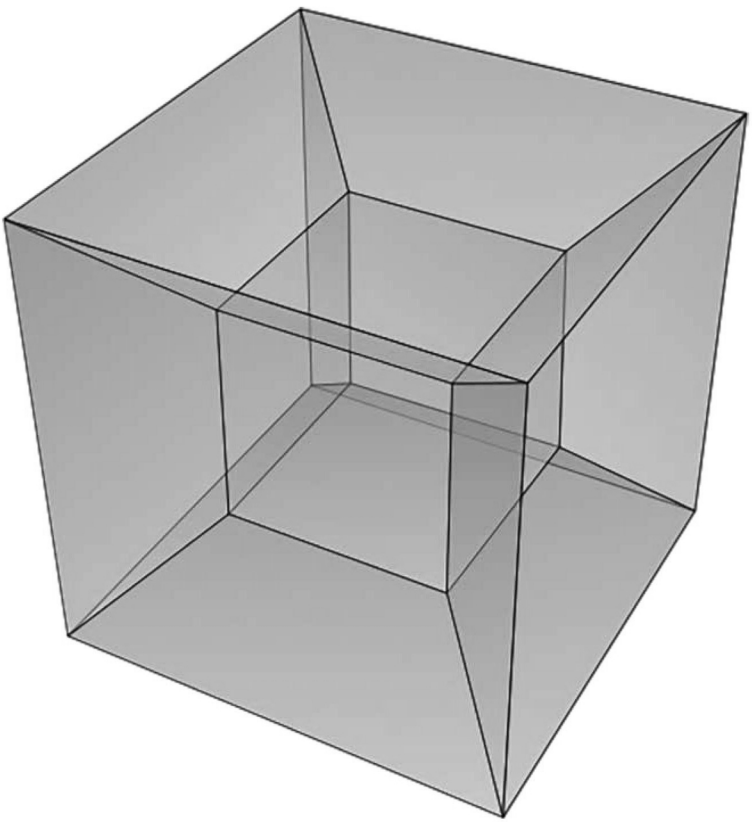
Purists may protest that Fermat's Last Theorem isn't strictly Diophantine because it refers to a variable exponent – the x to the n part. This is hair splitting. But, of course, the splitting of hairs is bread and butter to a mathematician. We will see later that Fermat's Theorem can be made Diophantine, but we are jumping ahead of ourselves a little.

A question that taxed mathematicians for many centuries was whether there are triples for higher powers, such as cubes. In other words, would the cube of the hypotenuse be equal to the sum of the cubes of the other two sides for some set of numbers? After much work, it was proven no triple exists which can solve the cubic equation. But what happens if we substitute higher indices?

The next shape to consider is the hypercube – a four-dimensional cube. That may stretch your visual imagination but the equation is simple, $3^4+4^4\neq5^4$. Again the challenge is to find a whole number solution for:



Hypercube

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"The hypercube of the hypotenuse is equal to the sum of the hypercubes of the other two sides." A picture of the hypercube might help you visualize things.

It's quite difficult to get your head around this shape because it is hard to think in four dimensions. This seems strange because we have no problem seeing in three dimensions on flat, two-dimensional paper – it's called a picture, but four dimensions on flat paper appears to stump us. Again there is no solution for a hypercube: no Pythagorean triple exists.

Fermat's Last Theorem asked whether this inequality for the cube and the hypercube is true for *all* higher dimensions – for the hyper-hypercube, the hyper-hyper-hypercube and so on. Tantalizingly, he claimed to have found a proof but wrote that it was too large to fit in the margin of his book. It's partly due to this arrogant annotation that it became the most famous puzzle in mathematics, frustrating mathematicians for nearly 400 years.

Hilbert's question back at the turn of the 20th century was whether a machine could find a proof of this conjecture by following a mechanical procedure, similar to our long multiplication example above.

The puzzle was eventually solved in 1995 by Andrew Wiles, a mere 358 years after Fermat claimed to have solved it. Wiles' proof runs to eighty pages of densely typed mathematical notation – considerably larger than the margin in which Fermat claimed his proof did not quite fit! There is an excellent book by Simon Singh – *Fermat's Last Theorem* – that tells the whole story.

We now know for certain, thanks to Wiles, that the answer is 'no'. There are sixteen answers to the two-dimensional triangle puzzle but there is none for any higher dimension all the way up to infinity. How might a computer tackle this problem and find a proof?

A computer could apply brute force and try many solutions; every combination up to 100 million has already been tried and no exception found. But, mathematicians are haunted by big mistakes of the past. There were theories they imagined to be true until someone discovered a counterexample. This sort of thing dogged prime number theorems.

Mathematicians don't like to look foolish and are suspicious of practical answers, "Well, I've tried it and I can't seem to find an exception." This sort of argument does not wash with them. That's what engineers and physicists do. Mathematicians are better than that!

Mathematicians want definitive answers; "It is certain no solution can exist", and these sorts of answers require an understanding of the problem to see *why* no solution could exist. That's a very high bar. What we need is a program that, rather than mechanically trying every possible

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combination, takes our problem and definitively says, "Yes, there is a solution," or, "No, there is not." There are plenty of man-made proofs of this nature. Pythagoras's proof there are an infinite number of primes is an example. Pythagoras did not have to try every prime number. He simply understood the nature of prime numbers and gave us a logical reason why it is so.

Mathematicians love a general solution. One way to solve Hilbert's 10th Problem would be to find a single mechanical way to solve *every* problem. If you could solve *every* possible problem, you could certainly solve Hilbert's 10th Problem. It turns out there is a way to test whether every problem has a mechanical solution – pose the Halting Question.

The Halting Question

I should say for a little historical color that the Halting Problem was not called that by Turing. The name was coined much later, in the sixties, by Martin Davis. Turing knew the problem by the less catchy name of the "not crashing" problem, or as he preferred, "Being circle free", meaning the program did not get caught in an infinite loop.

To understand halting we should imagine a brute force program stepping through all the possible solutions to Fermat's problem. If there *is* a solution this stepping program will eventually halt and answer 'true'. If there is not, the program will run forever. Can we predict a program will not run forever? At first pass this is hard. We can't watch it forever and say, "It never halted." So is there a clever way to do this? An algorithm perhaps?

The Answer to the Ultimate Question

The answer is 'No!' In 1936, Alan Turing proved there is no general-purpose mechanical way to tell whether a program is going to find an answer at all, much less what the answer is. This means Hilbert's Decision Problem has no solution; there is no general purpose algorithm which will discover all mathematical theorems.

Turing succeeded in proving this by turning the problem on its head. He proved that a crash detection program is unable to see whether it will crash itself. Since you cannot tell whether a program will crash – and by this I mean go into an infinite loop – you cannot tell if it will halt. He used the simple argument that since you can't tell if the crashing program will halt, you have already proved you can't predict if every program will halt.

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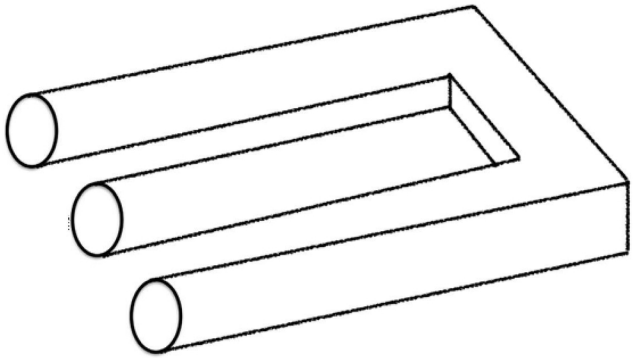

Impossible Shape

That is Turing's argument in a nutshell. But if that was too large a step, let's take the argument a little more slowly and prove it a couple of different ways. First, we will use a proof by counterexample, known by mathematicians as an 'indirect proof'. These may tax your brain. If you want a visual image to help with the idea of an indirect proof, take a look at the impossible shape. It is paradoxical, which means it does not exist. QED.

The Proofs

There are several ways to prove the non-existence of the Halting Program. I am going to present a few in the hope one of them will hit the mark and allow you to see why. The first proof uses a software flowchart. I have laid this out on the assumption the program exists and then attempted to apply it to itself. Unfortunately, the flowchart contains a paradox and thus there can be no Halting Program. The paradox is at once straightforward and confusing. It is a more elaborate version of the liar's paradox: "This sentence is a lie." If the sentence is true it must be false, and if the sentence is false then it must be true.

The Halting Program

Let us suppose there is a Halting Program. Remember that a Halting Program simply takes another program as input and predicts if it will halt or not. It follows there must also be a program called Haltcrash. Haltcrash goes into an infinite loop if it examines a program with input that halts, otherwise it halts itself.

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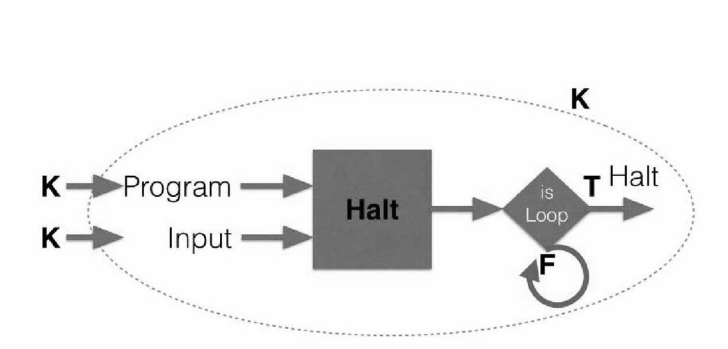

Halting Flowchart

Now we create a third program called RunMe. RunMe runs Haltcrash on itself. Still following this? Now execute RunMe with RunMe as its own input. What happens? The analysis is as follows:

1. RUNME started on input RUNME halts. If RUNME started on RUNME halts, then Haltcrash started on RUNME with input RUNME halts. If Haltcrash started on RUNME with input RUNME halts, then HALT decided that RUNME started on RUNME does not halt!

   Therefore,

   RUNME started on input RUNME halts implies that RUNME started on input RUNME does not halt. (contradiction)

2. RUNME started on input RUNME does not halt. If RUNME started on RUNME does not halt, then Haltcrash started on RUNME with input RUNME does not halt. If Haltcrash started on RUNME with input RUNME does not halt, then Halt decided that RUNME started on RUNME halts!

   Therefore,

   RUNME started on input RUNME does not halt implies that RUNME started on input RUNME halts. (contradiction)

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Both analyses lead to a paradox! There is only one way out. There can be no halting procedure. I'm sorry if this is quite convoluted.

Philosophical Proof

If you find these technical proofs difficult to follow, it may be easier to examine the problem philosophically. Consider the consequence of the existence of a Halting procedure. A Universal Turing Machine is a relatively small program. Roger Penrose gives a three-page example in *The Emperor's New Mind*, and Stephen Wolfram has implemented one using a cellular automaton with as few as five component parts.

A Halting Program running on such a machine should be able to compute all the knowledge in the Universe. Every structure, every work of literature, every galaxy could be the output of this single, simple program. My pocket calculator could, theoretically, paint like Picasso and compose like Mozart. All art, knowledge and science would be entirely determined in our Universe and we would have no free will. If you philosophically rebel against this then the Halting Problem must have no solution.

Gödel's Insight

Another way to understand this conundrum is through the earlier work of Gödel. Solutions to mathematical puzzles are neat, orderly sequences of statements where the problem is solved step by step. Computers are good at step by step processes. Surely a computer could simply proceed in a painstaking fashion to check all the possible combinations of words and symbols to discover a proof.

An analogy might be trying to find your hotel room if you have forgotten the number. You could simply find it by trying every room. As you progressed through each floor, you would try every corridor and retrace your steps to the main hallway before attempting the next. Eventually you would succeed.

Finding proofs of theorems is often understood to be the same sort of task: search systematically through all the numbers and you will find the solution. But this is not so: There is a hidden problem.

Although it is true to say problems and proofs can be described by numbers, they are not simply related like a lock and key. We need the first number to translate into a set of symbols meaning something about mathematics: for example, that x squared plus y squared equals z squared but for higher powers there is no equality, and the second number to

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denotes a set of sequential steps we can apply to demonstrate this fact. These steps must have meaning and obey the rules of mathematics, but what are these rules? Are they written down in a text book?

It turns out there is no way to find this set of rules; it is a super-infinite task. We would need to reach into our infinite bag of numbers and pull out rule after rule, turning each into a mathematical model that explains numbers and logic and what can be done with them to form mathematical statements. The number of ways to do this is not just infinity, but two to the power of infinity. This is the number of ways to permute all possible mathematical rules.

Your mind may be rebelling at this. Surely, if I have an infinite set of numbers I can just pluck all the numbers from my bag and then I am certain to have the solution. Unfortunately, it turns out there is no complete, consistent set of rules; no valid dictionary that maps all numbers to all of mathematics. That is Gödel incompleteness theorem.

Despite a fundamental limit on mapping all numbers to all of mathematics, there might still have been an algorithm which could practically find solutions for a given arbitrary problem. Turing proved this is not the case.

The Wiles Paradox

Turing showed us there can be no general purpose, mechanical procedure capable of finding solutions to arbitrary problems. A computer program cannot discover mathematical theorems nor write programs to do so. Yet computers regularly solve problems and generate programs. That's what software compilers do. This seems to be contradiction.

The solution to this apparent contradiction is to propose a boundary: a 'logic limit' above which computers may not solve problems. With a high boundary a general-purpose machine could solve most problems in the real world, though some esoteric mathematical puzzles would be beyond it. But if the boundary were low, many activities in our daily life would need some sort of alternative, creative thinking. It is crucial to know where the logic limit lies.

The Logic Limit

Amazingly, in many branches of science it is possible to pinpoint the exact location of the logic limit, but finding that boundary in mathematics has taken forty years work from some of the greatest mathematicians of the 20th century.

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The story starts back in the 1940s at Berkeley University with a young Julia Robinson, one of the first women to succeed in the previously male-dominated profession of mathematics. By all accounts, she had a wry sense of humor. When asked by her personnel department for a job description she replied: "Monday—tried to prove theorem, Tuesday—tried to prove theorem, Wednesday—tried to prove theorem, Thursday—tried to prove theorem, Friday—theorem false." Like Andrew Wiles, she fell in love with one of the great mathematical puzzles, and although she made great strides, the problem passed from her to Martin Davis for the next steps.

The final elements were put in place in the 1970s with the work of another young mathematician, this time a Russian – Yuri Matiyasevich. Robinson wrote to him when she heard of his proof, "To think all I had to do was to wait for you to be born and grow up so I could fill in the missing piece." The complete result is the Robinson Davis Matiyasevich theory which sets out the limits of logic and algebra. What, you may ask, do we mean by logic and algebra?

Mathematicians like to turn everything into logical statements, even ordering a round of drinks! The discipline of logic emerged from ancient Greece as the study of language. The starting point was the syllogism: Statements such as, "All cows eat grass." or Lewis Carroll's assertion, "There are no teachable gorillas." Over time the study of logic became ever more precise with, for example, the introduction of variables and equations; a=all cows, b=some grass. The formula "a eats b" translates by substitution into, "The cows eat the grass." This doesn't look much like a step forward but, trust me, it is.

The modern way to represent logic is using prenex normal form. This mouthful simply means separating relationships between things from the things themselves. The following four statements say the same thing, each in a more formalized way.

Speech: Harry loves Sally

Logical: x loves y (substitute Harry for x and Sally for y)

Formal: There exists an x, there exists a y (x loves y)

Prenex: $\exists x \exists y$ (x R y), Where R, the relationship, is 'loves'

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The final example is in prenex normal form. The symbol '∃' means 'there exists' and R stands for relationship in this equation. All logical statements can be translated into this form using a purely mechanical process. There is even a website that will do this for you. It's useful but I don't recommend it as entertainment!

In the example above, something exists in relation to the existence of something else: one person who loves another. Give me a name and I can look up the person they love. This is simple. A computer can easily solve such problems. Indeed there are hundreds of websites doing this every day. Once you've solved one problem of this type, you have solved them all.

We can rearrange Diophantine equations into many different prenex forms. The simplest form might be, 'there exists an x which solves the following equation, x equals three.' This would be written out as $\exists x, x=3$ and is of the ∃ class – 'there exists'. There are slightly more complex classes than our simple ∃ relationship: ∀∃∀ 'for all, there exists for all' or the class $\forall^2\exists\forall$ 'for all, for all, there exists, for all'. Each of these groups of equation is called a 'reduction class'.

One way to think about a reduction class is as a problem in topology, 'knots', to non-mathematicians. Imagine someone handed you a bunch of tangled cables – the sort of mess you get when they are thrown haphazardly into a drawer. You can tease them apart and rearrange them but you must not cut them or break any connection. Once you have done this you will be left with a series of cables on the desk. They are all separate, looped or in someway knotted together. Each cable has a fundamental topological arrangement: straight cables, granny knots, figure eight, and so on. You have reduced them to their simplest form, their logical classes. The same goes for logical statements. Once you have rearranged logical statements into their simplest form you can lay them out and group them together according to their complexity. Each group makes up a reduction class and you can ask whether that class as a whole is automatically decidable. It is a huge task to untangle and classify mathematical problems, and it took Robinson and her colleagues nearly forty years to succeed.

It turns out problems with a form as simple as ∀∃∀ (for all, there exists, for all) have no general purpose algorithm. Each must be examined individually and solved by something that is not a computer. This is a remarkable result as the logic boundary is set quite low. An ∃∃, (exists, exists), class of problem is automatically solvable by a general

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algorithm, but a $\forall\exists\forall$, (for all, there exists, for all), is not. Each individual type of problem within the class must be examined with insight and understanding.

Our lives are full of problems – playing chess, finding a mate, designing space ships and simply getting to work in the morning. Imagine we expressed everyday problems as logical problems. Where is the logic limit for life? We have no answer for this yet, but we do know the logic limit for computing; it is given by Rice's Theorem.

Named after Henry Rice, and proven in 1951 as part of his doctoral thesis at Syracuse University, Rice's Theorem states: "No nontrivial feature of a computer program can be automatically derived." You cannot tell if a program will halt with a given input. You cannot tell if one program will generate the same output as another. You cannot tell if a simpler program could be written to do the same task as a more complex one. In fact, no nontrivial thing can be proven. This means the logic limit in computers is low, and computer programmers have job security.

For Programmers

For the programmers amongst you, here are some of the things that cannot be done automatically even given infinite time:

- Self-halting Problem. Given a program that takes one input, does it terminate when given itself as input?
- Totality Problem. Given a program that takes one input, does it halt on all inputs?
- Program Equivalence Problem. Given two programs that take one input each, do they produce the same result on every input?
- Dead Code Elimination. Will a particular piece of code ever be executed?
- Variable Initialization. Is a variable initialized before it is first referenced?
- Memory Management. Will a variable ever be referenced again?

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Can humans solve 'unsolvable' problems?

The question of whether Fermat's Last Theorem could be solved mechanically remained unanswered until 1970 when Yuri Matiyasevich filled in the missing piece in Julia Robinson's proof. Matiyasevich used an ingenious reduction method to match up sequences in Robinson's theorem with a set of Turing machines. This showed that if Robinson's theorem was false you could solve the halting problem and since you can't solve the halting problem, then Robinson's theorem must be true. All this effort proved Diophantine equations have no general algorithmic solution. This was a hugely important result but, as we noted earlier, Fermat's Last Theorem is not, strictly speaking, a Diophantine. It is an exponential Diophantine equation. We still had no definitive answer to Fermat.

In 1972 Keijo Ruohonen and again in 1993, Christoph Baxa demonstrated that Diophantine equations with exponential terms could be rewritten as regular Diophantine equations with one additional complication – the necessity of adding an infinite set of terms to the end of the equation. In 1993, J.P. Jones of the University of Calgary showed the logic limit for regular Diophantine equations lies at thirteen unknowns. Matiyasevich had already pointed this out but never completed his proof. Since infinity is greater than thirteen, all exponential Diophantine equations are above the logic limit and, therefore, undecidable. Finally, we have a proof that Fermat's Last Theorem is unsolvable by a computer – or at least by a general purpose algorithm running on a computer. Matiyasevich went on to show many mathematical problems can be rewritten as exponential Diophantine equations and that much of mathematics is undecidable. For example, the Four Color Conjecture:

> *"Given an arbitrary map on a Euclidean plane, show the map can be colored in a maximum of four colors such that no adjacent area shares the same color."*

Meanwhile, Andrew Wiles, an English mathematics Professor at Princeton had been secretly working on Fermat's Last Theorem. When I say secretly, he had not told anyone in his department, and only told his wife late in 1993 when he suspected he might have a solution. He had been working on the problem a long time, having fallen in love with it at the age of 8! In 1995, after nearly 30 years work, he announced he

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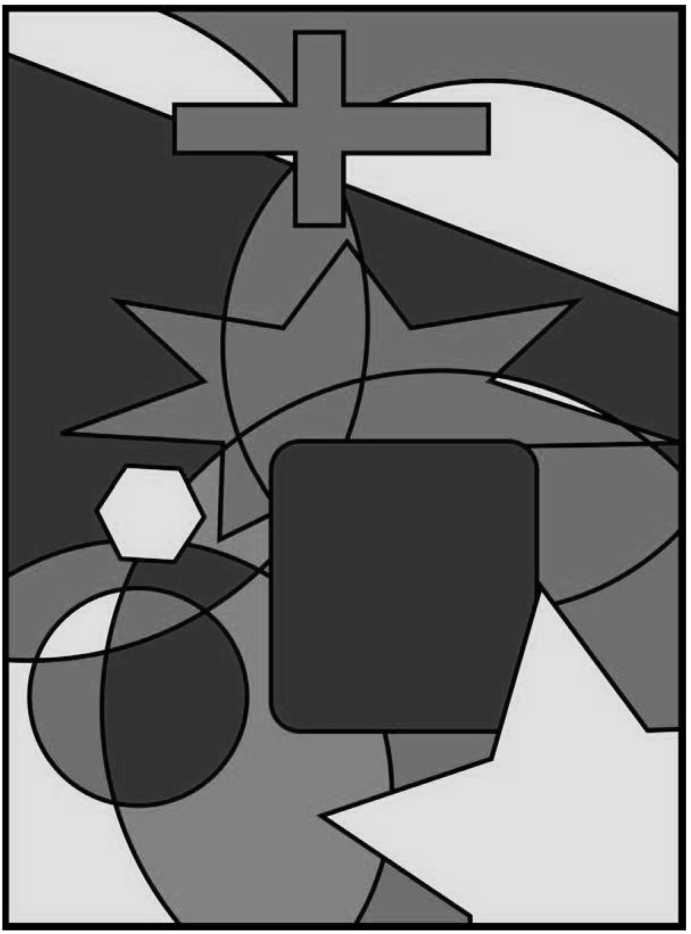

Four Colors is All You Need

had found a proof. He had solved an unsolvable problem, a problem that could not be answered by using a computer. Therefore, Andrew Wiles cannot be a computer!

As with all real-life stories, it was not quite as neat as this. It turned out Wiles' initial proof had an error in it, identified by one of his referees. Wiles had made an assumption about a particular number theory that had not been proven: it was still a conjecture. Working with another

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mathematician, he managed to prove this conjecture and so, two years after first announcing that he had solved Fermat's Last Theorem he could finally lay it to rest.

The Special Purpose Objection

Before I declare mankind's outright victory over computers, the Special Purpose Objection must be overcome. The objectors would argue that Wiles is a Special Purpose computer. Special Purpose computers are at no risk of breaking the Turing limit when they solve problems they have

Theorem (Undecidability of Hilbert's tenth problem)
There is no algorithm which, for a given arbitrary Diophantine equation, would tell whether the equation has a solution or not.

been programmed to answer. The objection misses the key point. I am not arguing *having* a solution to a given mathematical puzzle presents a difficulty to a computer; I am arguing a computer cannot *discover* one.

Take, for example, the search engine Google. If I type "where can I find the proof of Fermat's Last Theorem?" into the search box, it will retrieve a PDF of the proof as the third result. It appears this special purpose computer solved the problem. But you immediately see the difficulty. Google search already knew the answer, or more precisely had indexed the answer. The computer was not tackling a random problem from scratch. It was tackling a problem for which it knew the answer, or at least where an answer could be found. There is no sense in which the search engine discovered the proof.

To really understand this objection we need to examine exactly what Turing and Matiyasevich proved.

An arbitrary problem is one you do not already know the solution to when you write the algorithm. You can think of it as a variable. Is there an algorithm that can solve problem 'X'? The alternative is a special program. It can solve problem Y. Y is a problem it knows. It must have the solution coded somewhere within it in a computably expandable way. You might think of this as a table of constants; problem Y has solution 1, problem Z has solution 2, and so on. But it could be more subtle than that. Problem Y might have a solution which is encrypted so you cannot recognize it within the program, or it might even be the result of some

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chaotic equation so complex that the only way to see it is to run the program and watch the output: no form of program analysis will give you any clue as to what it produces. There is only one stipulation. The answer to problem Y MUST be held within the program as a computable algorithm. Put another way, the computer must already be 'programmed' to answer the question.

Could a human mathematician be pre-programmed from birth? Yes, there is no fundamental objection to this. Mathematicians could be born to solve the problems they solve. But this would present a couple of issues. Where is this program stored? And who, or what, programmed the mathematician? Could we perhaps find an experiment to determine whether mathematicians are pre-programmed?

One view held by philosophers is that the Universe programmed the mathematician. They believe we live in an entirely determined Universe with no free will. There is then no mystery as to how Andrew Wiles came up with his proof. He was destined to do it from the dawn of time. The ink that fell from his pen to the paper was always going to fall in just that way. We live in a clockwork Universe and although we might feel we have free will, this is an illusion. I simply don't believe this. If I am right and humans do exercise free will, Andrew Wiles cannot be a computer. And because Andrew is not alone in discovering proofs, those mathematicians cannot be computers either. Humans are, therefore, not computers.

The Chance Objection

I said there was no automatic way to solve any problem above the logic limit, but this is not quite true. There is one automatic method you could deploy to generate a non-computable proof, the infamous 'monkeys and typewriters' idea where we use random chance to generate information. Many people have suggested it is possible to write a play such as Shakespeare's *Hamlet* by simply typing random characters until we happened upon the play. The argument is flawed.

The first flaw is the process would take a super-astronomically long time. Even if every atom in the Universe were a monkey with a typewriter, it would take orders of magnitude longer than the age of the known Universe to come up with the script to a play or a mathematical proof.

The probability of finding a solution to Fermat's Last Theorem by chance is about 1 in $10^{50,000}$. That's 1 with 50,000 zeros after it. For a comparison, there are only 10^{120} atoms in the known Universe. To be, or

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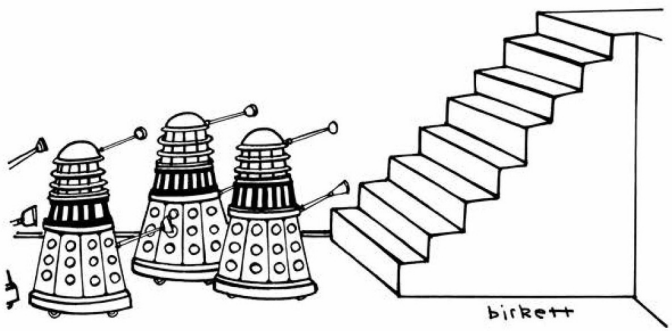
not to be, certain of finding the proof, you would need to run a computer long enough to calculate all the possible proofs up to the length of Wiles' solution. Currently, a computer using every particle in the Universe clocked at the Plank interval – the fastest conceivable computer running at 10^{34} operations per second – would take 10^{500} times the age of the known Universe to do this. If someone tells you this is *astronomically* unlikely they are making a huge understatement. A computer running until the end-of-time would only scratch the surface.

The second flaw is even more damning. Even if the monkeys succeeded in generating something interesting, something else needs to spot this. If an algorithm stumbled upon a proof of Fermat's Last Theorem, what would recognize it as such? There are no ways to systematically analyze proofs. There are no mechanical methods that understand these.



"Well, this certainly buggers our plan to conquer the Universe."

Dalek Trouble

"All non-trivial abstractions, to some degree, are leaky."

Spolsky's Law
of Leaky Abstractions

Consequences

Machines cannot discover theorems using algorithms, yet mathematicians do it all the time. Do the rest of us break the logic limit? It seems we do. People appear creative – painting, composing, sculpting and so forth. But, are these endeavors creative in the mathematical sense. To prove this, ironically we need to find something outside mathematics that is definitely non-computable. This is tricky. Most artistic things are fuzzily defined and there are no written rules we can apply. How can we prove a work of art could not have been generated by a computer?

Trivial proofs exist but they are rather contrived. For example, it would *not* be possible to make a film with a solution to the still unproven Riemann Hypothesis on the blackboard in the background of a movie scene. All the mathematics *Good Will Hunting* had been already discovered before the movie was made. New mathematics cannot be accidentally generated by a set designer – unless, of course, they also happened to be a world class mathematician.

These trivial proofs might lead a mathematician to argue the theory is proven. There *are* some artworks which cannot be computed. QED. But these are not very satisfactory proofs. I could create almost any movie I wanted without tripping over this rule. What I really wanted to know is whether *Good Will Hunting* as a whole could have been generated by a computer. Not that some weird version with a particular mathematical proof on the blackboard is forbidden. Movies are a difficult subject for

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this argument, but music is much easier to analyze. It is linear, highly mathematical and largely uniform by culture and language. Yet it is universally appreciated. Is music a computational or a creative endeavor?

Is Music Computable

To prove a piece of music is non-computable requires two tests. First to show we can 'reduce' it to a problem that is already non-computable and, second, to demonstrate it 'looks like' or 'sounds like' a piece of music. An accountant would say it needs to pass 'the smell test'.

The first non-computable problem to be studied in depth was Emil Post's Word Problem. Post was a contemporary of Alan Turing and studied at the Institute of Advanced Mathematics in Princeton. He solved the Halting Problem six months before Turing, but his proof used a complex recursive method called the lambda calculus. Turing's method was far more practical, which is why we now refer to Turing machines rather than Post machines. Later in his career, Post came up with a branch of non-computable mathematics called 'Post Problems'. They look like a puzzle you might find in a newspaper. Imagine starting with the word 'camel' and being asked to turn it into 'aardvark', using only a few simple rules. We'll make the problem very easy to start with: cam ↔ aard and el ↔vark. This solution is obvious; just do the substitutions and you are there. But what if the rules were a little more complex? Gennadií Makanin, a Russian mathematician based at the University of Moscow, found a set of extremely simple puzzles that are nevertheless non-computable. Here is one:

{"CCBB" ↔ "BBCC", "BCCCBB" ↔ "CBBBCC", "ACCBB" ↔ "BBA", "ABCCCBB" ↔ "CBBA", "BBCCBBBBCC" ↔ "BBCCBBBBCCA"}

Word Problem

Can a computer tell us which word problems have a solution and which do not? The answer is 'no'. Word substitution puzzles are a class of non-computable problem. Martin Davis proved this in 1948. Using a reduction argument we can use these word problems to prove some music is also non-computable.

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Let us start by substituting the notes of the musical scale for the letters of the alphabet to create a piece of 'music'. Since it is a direct analogue of the word problem, we have created a non-computable piece of music. It is definitely non-computable, but is it music? If it just looked like a random jumble of notes it would be unconvincing, but luckily there are many forms of music that look exactly like a word substitution puzzle. Bach's *Art of Fugue*, the canons of Tudor composers such as William Byrd and Thomas Tallis, and the works of Grieg all use sequences of chords that move from one to the next using substitution rules. If you were to listen to the steps in our word substitution music, they would definitely sound musical. I think they should pass the main artistic criticism – that they should not sound formulaic.

But is any actual human composition non-computable? Unfortunately, we cannot prove whether a particular piece of Bach, Tallis or Grieg is non-computable because we don't know the specific rules used to compose it. All we know are the general musical principles of harmony and counterpoint that applied at the time. We don't have these composers personal rule sets because they were held in their brain and they are, of course, long since dead. It is statistically likely that most pieces are non-computable because there are an uncountably infinite number of them, whereas computable pieces are merely countably infinite. But that's just probability; it is no proof.

I puzzled for some time whether there is a way to prove it but had to conclude it is impossible. However, and this is how creativity works, once I had given up on the problem, my brain continued to work on it. I was not conscious of this, I was only aware that failing to solve the problem annoyed me. I then had a Eureka moment. Although I couldn't *prove* a piece of music was non-computational, I could make one! – a piece that could not have been created using computation alone. This requires me to inoculate your brain.

Take either Andrew Wiles proof of Fermat's Last Theorem or Alan Turing's proof of the Halting Problem; both proofs are non-computable. Each document is made up of symbols, the Roman alphabet and some special Greek symbols such as α, β, ζ, and so on. Let us

Creative Inoculation

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write out the symbols in a table and assign a musical note to each. It is straightforward to put these notes into a synthesizer and play the piece of music. I have provided a link to such a piece. Warning: once you listen to this you will have been 'creatively inoculated'.

This resulting piece of music, based on the transliteration of a proof, is non-computable. You might immediately argue with this, "The piece of music was translated from proof text to music file using a computer. It is clearly computed.", but this is not my point. The music could not have come into existence in our Universe as a result of a computation. It is a computable translation of a non-computable string. It could not have been generated solely by a computer: It was done in two steps, the first of which could not have been computed.

If, up to this time, our Universe has never contained a piece of music that was generated non-computationally, it does now. If you listen to this piece, you will find it impossible not to be somewhat inspired by it. You cannot erase the experience from your memory. And once you have heard it you will have been creatively inoculated. I have defeated Daniel Dennett and his like, and given you creative freedom!

www.jamestagg.com/noncompmusic

Having made at least some music above the Turing limit I could declare victory but I want to go further. Using the same reduction method, I believe we can show all art is above the limit. First let's attempt novels and plays. Do you enjoy those crime novels by Agatha Christie and Colin Dexter? It must be possible to construct a plot sufficiently complex, and a murder sufficiently baffling that it exceeds the logic limit. I could keep extending this idea to provide any number of examples and, therefore, prove all art and creative output is above the logic limit.

There are many other arts we could apply this argument too. In the visual domain there are non-computable images. In principle, it is possible, to draw or paint things beyond the capability of a computer. Roger Penrose has created non-computable visual puzzles such as tiling an infinite plain with special jigsaw pieces. Creating an image containing a solution to his visual puzzle is non-computable.

This extension argument also applies to me. There is an argument that I am a finite being and therefore can be simulated by a computer. Since I can be simulated by a computer, I am the same as a computer and therefore incapable of non-computable thought. The argument is as follows: James Tagg will have during his life a finite number of inputs and, equally, a finite set of outputs. This means you could model me using a

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Jackson Pollock

computer. You could simply create a table of all the possible inputs and all the possible outputs I would make and this would be a perfect facsimile of me. A number of people have posed this as an argument to refute Roger Penrose's assertion that humans are capable of non-computable thought.

But this analysis misses a key point. There is no way to calculate all the contents of this table. My past could be tabulated. It is the history of all the things I ever did, but my future cannot. I might yet discover some great theorem that could not be computably generated. This would be a part of my output which could not be generated by an algorithm or any mechanical process. This forms a non-computational arrow of time; we can write down the past, we cannot write out the future. If a creative person such as Andrew Wiles could be simulated in advance, we would have an automatic way to find a solution to Fermat's Last Theorem. Since this is not possible, it follows that creative people cannot be simulated. This also means the Turing test is not passable by a machine. Humans can create; machines cannot. That is the difference.

Will Computers Take over the World?

Ray Kurzweil, the American inventor and futurologist, has suggested computers are getting exponentially faster and will soon reach such immense power they became effectively infinitely powerful. They could instantly answer any question posed and solve all our engineering problems. He dubs this point 'the singularity': a point of near infinite

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Watson and Our Future?

computing power and therefore universal knowledge. This could herald a Utopian future; global warming, cancer, all things of the past. But computers might just as easily become bored and determine we humans are the real problem. If we are lucky, they may treat us as amusing pets. If we are unlucky...

These consequences might have come to pass if the answer to the Halting Problem were 'yes', but as the answer is 'no'! This is not the future we face.

Mummy, where do Bugs Come From?

One consequence of the logic limit provides a theoretical basis for the origin of computer bugs. The mention of 'bug' conjures up stories of dead creepy crawlies stuck in early computer circuits, but the term had been in use for over 150 years before the computer was even invented. Bugs are not simply annoying mistakes.If you misspell my name as Stagg instead of Tagg that's just carelessness. Real flaws creep into a computer program when you fail to understand Brooks' essential complexity, or by my terminology, you stray above the logic limit without realizing it.

Imagine we have created a piece of software. The software goes into test and is subjected to a range of use cases. Some of these will fail because we did not take into account all the real world possibilities. Then a strange thing happens. We get trapped in a loop of patching the errors in the program in a rather mechanical way. Find an error, patch

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it. Find another, create a work-around, and so on. By doing this, we are effectively mechanically generalizing our solution. This is forbidden as it breaks the Turing limit, so we can't mechanically solve a general logic problem above the logic limit. We need instead to use intuitive or creative thought. In our panic we did not stop, take a step back and engage our brain. Instead, we attempted, unsuccessfully, to blindly hack our way through the problem.

If we eventually succeeded in perfecting the code this way, we would have broken a fundamental law of the Universe. Something nasty would have to happen to prevent it, such as rupturing the space-time continuum or an event equally horrible! Luckily something prevents this and keeps our Universe intact – BUGS! Bugs stop us breaking Turing's limit.

The next time you curse a bug, remember if they didn't exist you'd be in danger of causing a logical paradox. There is no problem in redefining the domain and then creatively producing an all-encompassing design, but, you can't patch and hack your way there. This theory of bugs leads to an explanation for some modern programming rules of thumb.

Written specifications are valuable because they force you to lay out *the whole* problem. You don't need to be detailed regarding the depth, but should be expansive about the breadth, covering all the logical complexity. This might result in many details as a by-product, but a specification needs to delineate the edges of the problem space and not simply focus on a few key points.

Writing the tests for the software in advance is helpful as it is likely to tell you early whether your design encompasses the whole problem space.

Also, building a prototype, throwing it away, and then building the real thing can help greatly. It may be the only way to examine the edges of the problem space in detail. Armed with a full understanding, you can then imagine solutions to the complete problem in a single creative sitting. Whatever techniques you use to improve the quality of your software, remember you are engaged in a creative process that is not, itself, open to automation.

The Art of Programming

Programming is an art: a creative endeavor. It is also, of course, highly scientific. When you work with a good programmer – and I have been fortunate to work with some of the best in the world – they all follow a similar process. First they talk with you at length about your needs

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Geek Humor

and examine the full scope of the problem space. Even if you say, "Oh don't worry about that bit," they always will. They want to know about everything. Then, they write a high-level list of features, some simple block diagrams, and occasionally a flow chart, only then do they begin to code, ticking off the list as they go. Sometimes, they will check to see if their list is the same as your list but more often they will come back and just check the high-level purpose. "If I give you something that achieves this, will that do it for you?" They test as they code so you end up with is something that meets your high-level purpose, and can prove it does so in its own right. At the end of the coding they write out the specification for the project so that they can remember what they did, or a colleague can pick it up in the future.

This is *not* how students are taught. Students are told to write a detailed specification at the start and then simply implement it. If you've been following my argument, they are being taught to do something impossible! There is no 'just' to programming. Sometimes teams are even split up so that one person writes the specification and another the code – again an impossible task. If the specification was the *answer* to the problem, it must have required creative thought to develop and so would be as complex as the program itself. Since it is not yet a program you cannot test it, so it becomes an untestable solution to a creative problem. Since the specification is *not* the answer but rather a general list of tasks, the great danger is to give it to a separate programmer and

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they implement it mechanically. You see, of course, the problem. It will be riddled with bugs because they have missed the creative step of imagining the whole problem and solving it in the round.

This fundamental misconception of software is common in many organizations. "Ah," says the finance director, "I'll write a very detailed spec and then we can get someone cheap to *just* program it." This does not work. If the finance director has done the creative work of taking a problem and turning it into a detailed specification for the programmer to 'just program' – removing any ambiguity and therefore the creative overhead – he will have all but written software himself, albeit in a computer language of his own making. On the other hand, if the specification is a linear list of issues with no creative thought, he will not have reduced the time needed to program. He may have improved the quality by effectively getting a second pair of eyes onto the requirements gathering stage, but this does not help the programming effort itself.

Ideally, you should never split up specification and coding. It is a creative process best handled by very small numbers of people working intensively on it. Of course, there is one big problem with this: some software tasks are huge. Before we look at the science of splitting up a software project, it is worth pointing out that many of the most famous projects were written by one man. I have met many of these people and they are all exceptional – Linus Torvalds, Linux; Anthony Minessale, FreeSWITCH; Daniel-Constantin Mierla, Kamailio; Eric Allman, ,SendMail. Before splitting a project between many people, it is worth considering whether you can give it to just one individual. To do this you

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will need to unload this person of ALL interruptions and administrative burdens. This is the most effective way to solve a creative programming task. Practically, once your task is over the limit for a single human, a software project must be split up. This requires great care. Dividing a problem efficiently means specifying the interfaces between them and decoupling the components. This is the art of an architect or a producer in the creative arts. The creative process operates similarly in other walks of life. There are many examples of successful creative duos – Rogers and Hammerstein (*The Sound of Music*), Ben Elton and Richard Curtis (*Blackadder*).

Good managers, therefore, find ways to break projects into manageable sub-projects that can be worked by pairs or rely on single super-programmers with support around them. If you are lucky enough to gather together a group of super-programmers and can divide a problem efficiently amongst them, you can achieve great things. You see this pipeline in movie production. A script writer generates a script creatively. The casting director finds the actors, a director is in charge of filming, and an editor puts it together. In very great movies you will often find a great director or producer who had a hand in almost everything holding it all together. They are often accused of micro-managing but you can see that's what they must do. They are the super-programmer with the whole creative work in their head, and an eye on the audience and financial backers.

If you talk with great programmers you will be amazed by their breadth of technical, commercial and product knowledge. Why do they need all this commercial information to do their job in the round?

Rules and Tips

I began writing some rules on how to split up a project, and almost immediately ran into exceptions and special cases. The job of dividing things into sub-tasks is, itself, a creative problem and must not be done mechanically. Any 'one size fits all' rule will fail and you must apply domain knowledge and careful thought to the process.

It is the job of architects or a senior engineer to split projects into smaller chunks. To do this they must accurately 'guess' boundaries between subtasks to create self-contained, creatively solvable problems. This can be done by either vertical or horizontal abstraction. Both have their problems.

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Horizontal abstraction is the simpler of the two to understand, and the more common. Computer systems are built 'on the shoulders of giants'. That is to say we no longer need to place individual pixels onto the computer screen. We can assume a computer will draw a square if we specify the dimension and coordinates of the center. That's abstraction. Today's computers are even more helpful. We can ask them to draw a rotating cube lit from a certain angle and the computer will do the whole job for us. But, there are always practical limitations to this.

I want my cubes to move around the screen naturally but I am not sure what physics model has been implemented. What will happen when they bump into each other? If the abstraction is not thoroughly thought through they pass through each other in a very odd way, breaking up and showing me they are really made of triangles, the illusion of three dimensions is lost. Whenever we work at an abstract level, we risk being exposed to its inner guts at some point. Joel Spolsky, a computer scientist who worked on Microsoft Excel, proposed the Law of Leaky Abstractions to explain this. An example of his law in action is the TCP/IP protocol stack that transports data over the Internet. The stack is hugely reliable, yet I have to debug one of these stacks at least four times a year!

The problem is that the TCP (Transmission Control Protocol) is designed to provide reliable delivery of information: internet pages, my bank account and the like. But, the internet protocol 'IP' on which it relies is only designed for best-efforts. When a link loses a packet of information, the TCP has to retransmit it. This takes additional time. TCP provides an abstraction of a reliable connection, but the implementation is not as robust as it may seem, and the details leak through as variable latency and throughput. This explains why your web pages sometimes do not completely render. You are told it is reliable, but often it is not! Experience is so valuable to a programmer because they know which of these specifications to take with a pinch of salt and when they are likely to leak. They are battle scarred by previous naivety.

I think Spolsky's Law follows from Rice's Theorem and ultimately from Turing's no halting proof. If leak-less abstraction was possible you could, in principle, write a recursive partial halting solution. By layering abstraction on top of abstraction you would be able to solve some very complex problems, eventually including the Halting Problem. We know this is impossible, so non-leaky abstraction cannot exist.

The other method of splitting software is vertically. This is often done following the natural boundaries of an organization: functional or geographic. Again there will be leakage between the systems; the data you get from the finance department might not be detailed enough for

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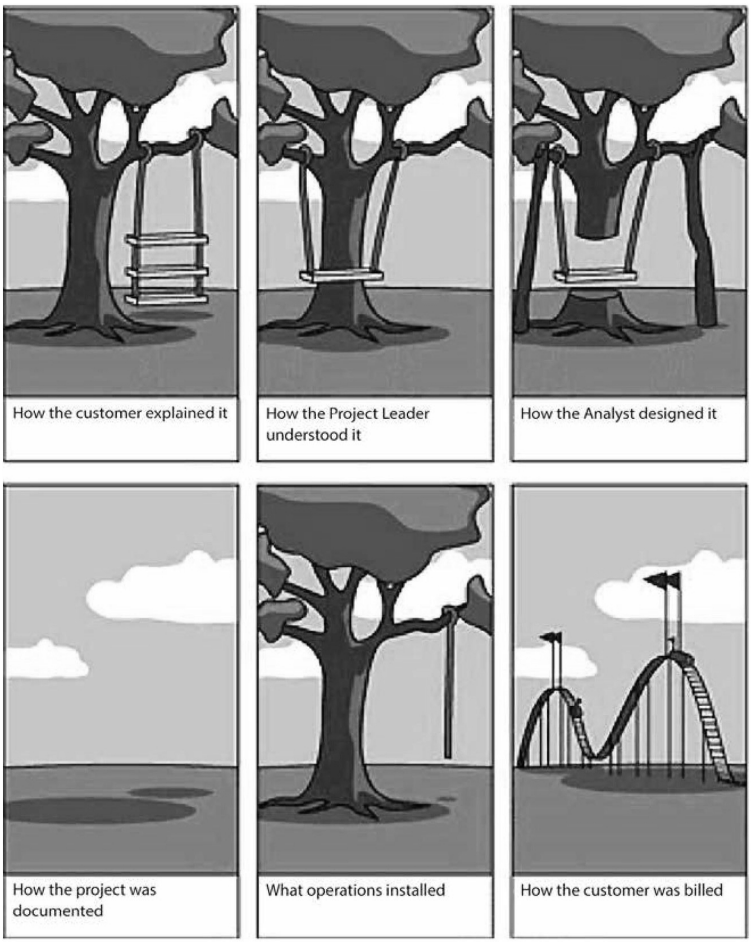

Specification Cartoon

the engineers or vice versa, and so groups have to interact. The main problem with vertically divided software is each group tends to reinvent the wheel, so you end up with multiple similar implementations of the same thing.

All said, the architectural job in software is a dynamic one. You can split up software into separate elements but you must take into account the leakage between them. When you detect a leak you must bring people together to collaboratively solve the problem, rather than insisting on the original partitioning. While doing all this you must keep track of the overall aim and all the irritating small details contained in the many

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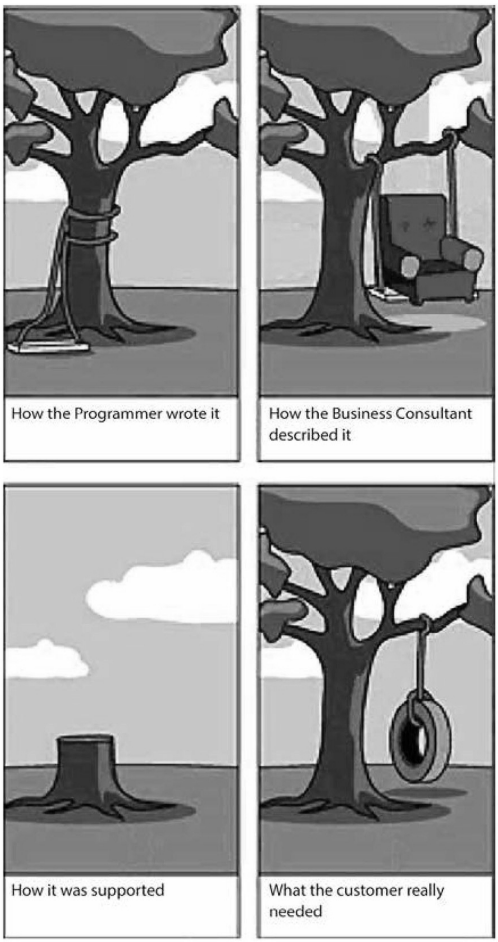

lists that form the project specification. I should confess that I am no great fan of specifications, because they can mislead you into thinking you've solved the problem, but I concede a good specification is helpful. Spolsky's Second Law is 'Always write a specification.' Engineers should collaboratively write the specification as a response to the desires of the project creators. But they must not blindly implement the specification they've been handed. They must not forget the creative element.

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The Role of 'Process' in Creativity

We hear a lot about 'process' when developing software and other creative tasks. The first thing to realize is process does not write software and every moment spent on process is a moment not writing software. Excessive process can bring the productivity of the average programmer down from a thousand lines per day to one. On the other hand, we all know that using no process to write software results in useless software. Good solo programmers, playwrights or composers are surrounded by lists and post-it notes full of process. Where is the balance to be struck?

In my view 'process' is there to help humans with the tasks we find naturally difficult. Humans, as we know, are dreadful at remembering lists of symbolic information. Give a human ten numbers to memorize and they will quickly forget them. Give Microsoft Excel ten numbers and it will remember them forever, or, at least, until your next upgrade! So the first job of process is to collect lists of things and sometimes even lists of those lists.

Another significant affliction affecting humans is procrastination. We tend to put off decisions. Process can set waypoints; when will the job of splitting a project occur, when will we begin the test, and so on.

The third job of process is to keep track of the division of labor – if the project has to be divided. Who will do what? Essentially we are back to lists again.

The most important job of process, in my view, is to keep track of scope. 'Logical scope creep' when unrecognized destroys software projects. Scope creep is fine if it just adds more linear work. "Could we add three more product types?" "Could you do another language?" "Can you make this interface prettier, less cluttered?" It may cause a busy team to groan, but it does not damage the integrity of the design. To put it back in Brooks' language, accidental creep is fine – provided you add some resource. Essential creep is not. Adding the french language prompts to a project in English might be fine, putting language translation into a project may be a step too far. The project may have strayed into a different logical class. Increases in logical scope often require redesign, you must stop and re-architect if you are to avoid bugs in plague like quantities.

If programming software is a creative task, how can we help improve productivity? The most important factor is to provide uninterrupted peace and quiet. Programming is a task where people need to hold many ideas in their head at the same time, and this requires deep concentration. To get some idea of the creative process at work, listen to the excellent TED lecture by John Cleese.

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A common and costly mistake is to put off thinking about a class of things you are going to need in the next release because of time pressure. 'Time out, that's for the next release' and similar statements spell disaster for the future of a project as when you come to the next release, you may have to rewrite much of it from scratch. This is why good architects are so valuable. They anticipate the future even when they are told to ignore it and ship now!

Just as there are artistic geniuses, there are programming geniuses. Hold onto them if you get one. They are rare. We don't know if they can be made or they are lucky accidents, but statistics shows that some people are 1000 times more productive at writing code than the average. If you can find lots of them and make them work together you will build the next Google or Facebook. If you have a tight deadline, a super-programmer may get you out of a hole, producing in a week what might otherwise take a year. Remember your great programmers will most prolific if you can get process and distraction out of their way. Just make sure they have a clear idea of purpose.

Laws

A programmer interrupted eight times a day does no work.

A creative person interrupted eight times a day does no work.

Programming is a creative endeavor.

There are creative geniuses. Hold onto them.

Bugs save us from collapsing space-time when we are lazy and try to use mechanical means rather than creative thought to write software.

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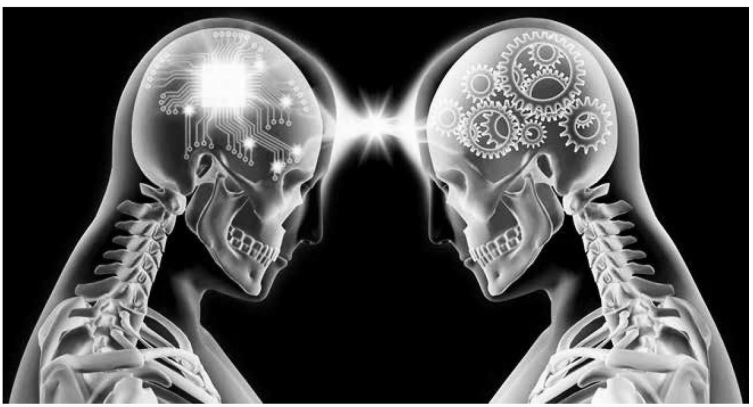
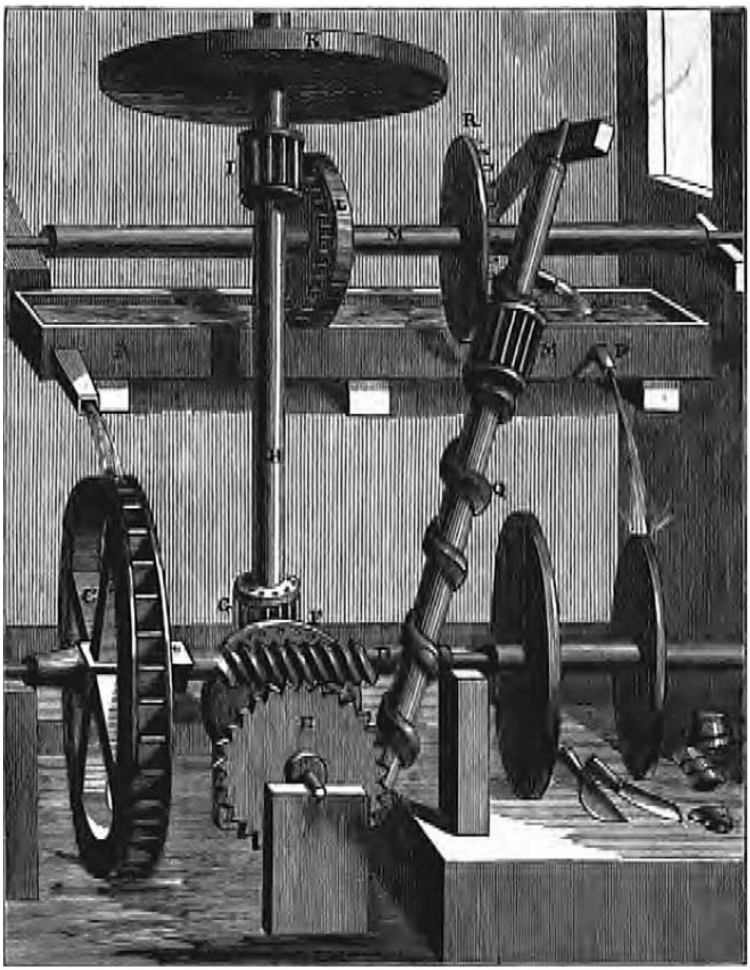
Chapter 12

HYPER-COMPUTING



What's in a Brain



Perpetual Motion from the 1600s

"If you are in a spaceship that is travelling at the speed of light, and you turn on the headlights, does anything happen?"

Stephen Wright

If you believe humans outthink computers, be warned; you are in controversial territory. This would need a hyper-computer and many scientists speak of these in the same breath as perpetual motion machines.

I'm not sure it's an entirely fair analogy. We understand machines, and the physical laws of our Universe forbid perpetual motion. We don't understand brains, so we can't reasonably dismiss human hyper-computing. Humans commonly demonstrate one clear example of thinking which appears to break the Turing limit, namely finding solutions to mathematical puzzles. We need an explanation for this. Let me take you on a whistle-stop tour of all the schemes people have imagined that might lead to a hyper-computer.

A hyper-computer is a machine that can calculate a function which a Turing machine can not. For example, when given a number denoting a problem such as Fermat's Last Theorem, it can give me in return a number representing a valid proof. We are not concerned here with speed. We are talking about fundamental 'do-ability'. Such machines are often dubbed 'super-Turing'.

Epic Fails

Let us first look at some proposals that blatantly fail. My children call these 'epic fails', and they are the perpetual motion machines of the hyper-computing world.

Could we run many Turing machines at the same time, perhaps even an infinite number? Then we would have a much more powerful machine that must beat the Turing limit.

The answer is no.

Turing machines are already infinitely powerful and we know from our chapter on infinity that all countable infinities are the same. Infinity plus infinity, infinity times infinity, infinity to any power; all are equal. One single, fast, one-dimensional machine can simulate them all. We get no greater power with an infinite number of similar machines.

The next technique which might realize a hyper-computer is to have a machine which simultaneously runs every possible branch in a program. Each time the machine gets to a point where there is a binary decision, it can take the 'yes' branch, spawn a copy of itself, and run the 'no' branch as well. Logically this machine should be able to calculate anything since it tries *every* conceivable option. The process is called non-determinism. This doesn't mean the computer has free will. It just means the computer never chooses one option over another. It just

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assumes each could be correct and travels down both. Solving a problem using a machine like this can be fast. The problem is this machine has no greater power than a regular Turing machine. Let me show you why.

A non-deterministic machine is essentially the same as a single Turing machine; each time there is a branch in the program you would start running two processes. The first process works on every even tick of the computer clock and the other on every odd tick. Now we have a single machine running two branches at the same time. Using this trick over and over again, a single machine can run a program exploring every possible branch. Although it generates an enormous number of branches and takes a huge time to run, it is still a single machine and we have an infinity of time on our hands. Therefore, the machine is limited as before.

We are not doing well so far and we have already exhausted an infinite number of options! Let's try a different tack. We know true randomness is non-computable, the sort of randomness generated by the Lavarand we examined earlier in the book. Might this help? Truly random processes can't be simulated by a computer. If we throw this into the pot might it let us compute something a Turing machine cannot?

Again, no.

This idea still only generates a machine as powerful as the non-deterministic machine above. A non-deterministic Turing machine runs *every* possible program. All a random one does is choose *some* of the same paths at random. It, therefore, can't be any *more* powerful. The one difference is that it can generate non-computable numbers. However, the only interesting characteristic of these numbers is they are truly random and this randomness was an input. Their presence does not make the machine any more powerful.

There are quite a few proposals for hyper-computers that are just cleverly dressed up versions of the machines we have already met and dismissed. For example, it has been proposed the Internet could form a super-Turing machine. This is known as a site machine because the processing is distributed across many sites linked together through the Internet. It is proposed each site could act as an oracle to the others. This is quite an elegant idea, and some proofs have been offered that show such a machine is capable of generating non-computable functions. The problem with this idea is that you can simply draw an imaginary line around the whole site machine and it looks exactly like a big Turing machine. There is no conceptual difference between such a machine and a regular computer with subroutines. After all, that's in Turing's

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original proof. Again we have reached a dead end. We need something qualitatively different to a traditional computer in order to break the Turing limit. The obvious place to turn is the quantum world.

Quantum Computers

Quantum computers have had an extraordinary run in the press recently. It has been variously claimed they offer limitless computing power and can break all known security schemes; cracking, for example, the prime factors that form the basis of public key cryptography. This is big news. These codes are used to protect all the financial transactions we make on the web.

In a regular computer, bits of information are processed by switches that make simple 'yes' or 'no' decisions. In a quantum computer each switch can take both the yes and no branches, at least for a short time called the decoherence interval. The calculations are said to be superposed. This allows a quantum computer to calculate exponentially, rather than linearly, as the number of logic gates increases. Grover's algorithm and Shor's algorithm use this superposition to speed up factoring numbers and looking things up in databases, respectively.

Grover's algorithm gives us the ability to find something stored in a random place without having to look in every box. If you think about a standard search, say for your lost car keys, you must look everywhere to guarantee finding them. It does not much matter in what order you do it. When you are halfway through the search, you will be 50% likely to have found your keys. But, with a quantum computer, you can be fuzzy and look in many places at once. A quarter of the way through a quantum search, you are 50% likely to have found your keys. That might sound like a small improvement, but when working with very big numbers, it makes an enormous difference.

Shor's algorithm works a little differently and, yes, it does allow a quantum computer to break Internet encryption, so the newspaper headlines are true up to a point. Some time in the future we will need to move to a more secure type of encryption.

The largest quantum computers today can process 300 qubits at a time or remain 'coherent' for about two seconds. These results are pitifully low. The largest prime number factored so far is 143, a mere 7 bits long! By way of comparison, internet security routinely uses 1024 bits. But, quantum computers are improving exponentially faster than classical computers: They really do change the rules of the game. If you remember our discussion of chess, the quantity of space needed for a

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calculation can be the limiting factor. A quantum computer is very space efficient. When the computer branches and makes a copy of itself, it does so without needing more space. There are two theories for how it does this, (well, three, but the third is highly controversial). The first theory is the computer doesn't need the space because it hasn't made its mind up yet; somehow the calculation floats in an undecided state. The second is that the computer puts a copy of itself in a parallel Universe each time it branches. When the calculation is over, either all the Universes collapse to a decision, or *every* possibility is chosen in some Universe or other and they all go on their merry way! This is the 'many-worlds' interpretation of quantum mechanics and we will return to it later in the book.

We have now explored all the straightforward ways to make a hyper-computer, and all have failed. We need something still more exotic.

More Horse Power Needed

Is there anything more powerful than a Turing machine?

Yes, in theory, there is.

The first person to explore ways of breaking the Turing limit was Turing himself. He cut right through the problem by proposing the existence of an oracle function. At any point in a computation, you could ask this function a question and it would give you the right answer.

We must leave completely aside the question of how this wonderful oracle function is constructed. All we know is it can't be a machine. If it really existed, a Turing machine that was able to consult it would be able to answering any question you put to it. That is a hyper-computer.

Unfortunately having access to such an oracle does not get us far. We can use it to compute numbers we could not otherwise have obtained – or answer a single question – but it does not give us a general-purpose way to solve further problems outside of the logical area we asked it to answer.

Each time the oracle answers a question we break the limit a tiny bit. Each question and each answer moves us forward, but does not give us something universally applicable. If I ask the oracle to prove Fermat's Last Theorem it will give me that answer, but this does not turn me into a creative mathematician, able to prove any other theory. You can test this by typing a mathematical question into the Google search box. Does obtaining an answer make you better at mathematics?

In any case, an oracle is not and cannot be a machine, so it does not lead us any further in our quest to build something super-Turing.

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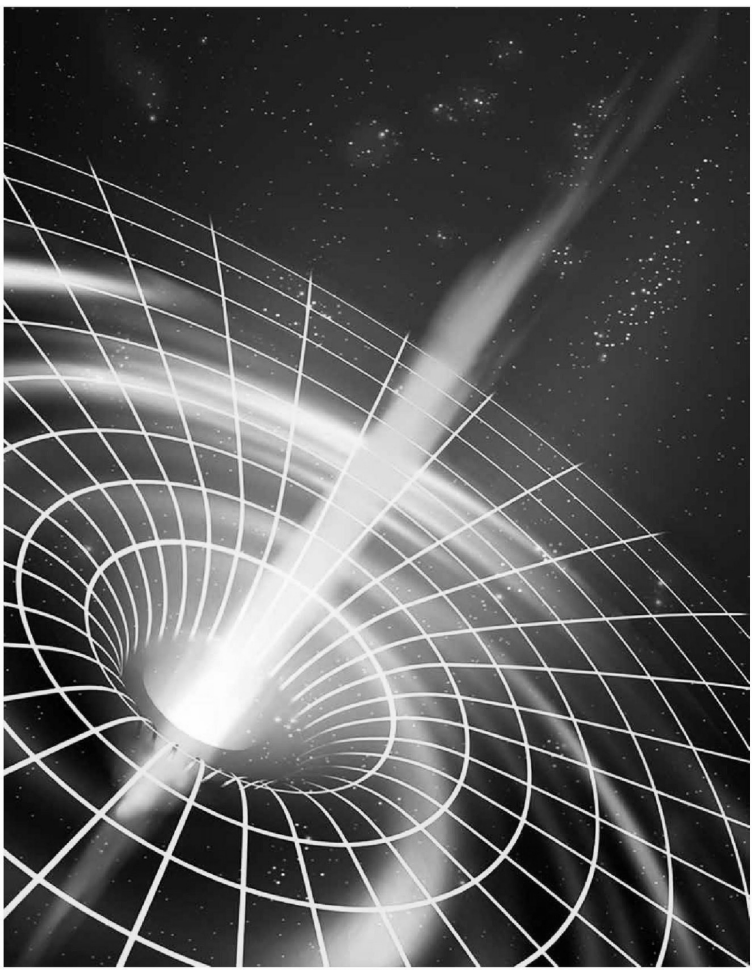
The Weird and Wonderful

There are some really weird and wonderful proposals for machines capable of super-Turing thought. Let's take a bit of a flight of fantasy.

If we could make a spaceship survive the inhospitable environment near a spinning black hole, it might be possible to send information backward in time. We could see the answer to a calculation before we had to go to the trouble of calculating it in the first place.



Black Hole Malament-Holgarth Space

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David Malament and Mark Hogarth of the University of California, Irvine have proposed a form of space-time called the Kerr Metric. This allows a machine to break the Turing limit, but has the drawback that as it does so it falls through the event horizon and is sucked into the black hole. We might discover new information but are now trapped inside the event horizon unable to communicate it – a form of cosmic censorship.

Candidates for a hyper-computer that could fit inside a human brain include mathematical curiosities which stretch the concept of infinity. The easiest to understand is the Zeno machine. In a Zeno machine a computer runs each successive step of a calculation in half the time of the previous step. The computer can pack an infinite quantity of computation into each finite time interval and can therefore outperform a Turing machine. This theory fails at a practical level because we simply can't build such a machine.

There are numerous weird suggestions for mathematical super-Turing machines, and many are described on the Internet. They all fit broadly within the two models above: modifications to space-time or peculiar mathematical paradoxes. The inspiration for the true solution to super-Turing thought may lay in there somewhere, but there are some more plausible proposals to look at next.

Plausible Ideas

I have characterized the next set of ideas as plausible, but they may still be highly controversial. My only criteria for plausibility are that the mechanism must outperform a machine limited to counting numbers, and it might fit inside our skulls. No black holes allowed.

One interesting proposal for a super-Turing machine that could fit inside our skulls is the Adaptive Recurrent Neural Network, 'ARNN' proposed by Hava Siegelmann of the University of Massachusetts, Amherst. An ARNN is a neural network with real number weights. As you recall, real numbers are equivalent to the continuum infinity, a larger infinity than that of counting numbers.

This is the infinity that defeats a Turing machine, and Siegelmann harnesses it as the basis of her computing machine. She argues that, although the machine cannot be programmed as it is impossible to write real numbers down, once it is running, the weights diverge and real numbers will be used within the network. These real numbers allow the machine to compute using numbers that are not, themselves, computable

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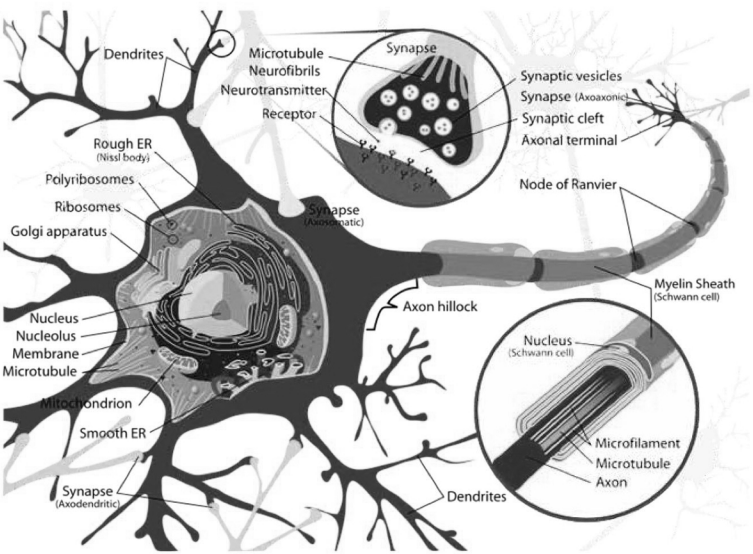
and this is where the machine's greater power comes from. Of course such a thing might easily fit inside our skulls, and the physics within our brains are certainly capable of using real analogue values.

The biggest stumbling block for Siegelmann's idea is the information that gives her machines their power is fine-grained and easily destroyed by noise in the environment. This is not just from the sort of electrical noise we hear when our cell phones interfere with the radio, but the precision required by her machines is so exacting that anything might interfere with them. For example, gravitational waves caused by the motions of nearby stars would disturb calculations at only the fiftieth decimal place. Since it is these digits that constitute the difference between an ARNN and a regular Turing machine, most people conclude ARNNs can't work. There is one effect stemming from the quantum world which might come to the rescue. The potential to do something in the quantum world is sufficient to modify the behavior of a system even if the system does not actually do that specific thing. This is called a counterfactual process. The possibility an ARNN might perform infinite precision calculations may be enough to give the machine the edge, even though in practice it is disturbed by noise. This is speculation upon speculation, but interesting nevertheless.



Neurons and Microtubules

Roger Penrose is fascinated by such counterfactual experiments and is inspired to think such effects might have a role in non-computable thought. It is his 'machines' we will look at next.

Penrose-Hameroff Machines, aka Brains

Roger Penrose of Oxford University and Stuart Hameroff of the University of Arizona have proposed a very different way to understand the workings of the brain. They focus on the much smaller scale structures within neurons called tubulin microtubules. If you watch a brain form, the dendrites grow towards each other, twisting and turning rather like the growth of a plant as viewed in a slow motion nature film. This motion is controlled by micro-tubular structures formed of a protein called tubulin. Tubulin is made from peanut-shaped polar molecules that self-assemble into helical tubes with a radius of just seven molecules. The tubes bundle together to form the backbone of neurons. The peanut-shaped molecules are bipolar switches and can flip between two states. This allows them to bend into different shapes and, in the most extreme example, to flap fast enough to propel small organisms such as paramecia. It is also, interestingly, the protein that unzips the double helix when a cell divides, and so plays a fundamental role in our evolution.

Penrose and Hameroff suggest these tubes form the true processing element in our brains. The walls of the tubes are formed of successive alpha and beta tubulin molecules. Each of the tubulin molecules can flip between two states, propagating a ripple along the tube wall. The scale is small enough for quantum effects to matter, and Hameroff suggests quantum error correction keeps the ripples from decohering too fast. Because the processing is happening at a molecular level rather than at the scale of a neuron, the brain would be considerably more powerful than a count of its neurons would suggest. They propose increased computing power would stem from three sources: There are many more tubulin molecules than neurons; the micro-tubes could perform quantum computation, and the micro-tubes are capable of non-computable, conscious, thought.

Measurement of a quantum process is the only candidate we have for a non-deterministic physical process today; all other physical processes are deterministic. Penrose argues that quantum processing in the brain spontaneously collapses in decision making because of the interaction between quantum superposition and gravity. The arguments are put forward in two books: *The Emperor's New Mind* and *Shadows of the Mind*. This theory remains controversial for two main

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reasons. First, most people see no need for super-Turing thought. They believe computers are sufficient. Second, they believe the brain is not a hospitable place for quantum effects: it is too hot and too chaotic. Indeed, until recently people assumed quantum effects would have no place in biological entities, but this orthodoxy has recently been overthrown by the discovery of quantum processes in photosynthesis. The paper by Travis Craddock of Nova and others suggests there may also be quantum structures in the neurons of our brains and we might possess quantum computers after all. But, remember, Penrose and Hameroff don't only need quantum coherence within our brain to explain consciousness. They also need gravitational effects.

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Chapter 13

HYPER-COMMUNICATION

World Wide Communication

"The single biggest problem in communication is the illusion that it has taken place."

George Bernard Shaw

Each Christmas I buy the *Private Eye* annual (an English satirical magazine) only to be slightly disappointed when much of the humor falls flat, yet I can watch the TV current affairs quiz 'Have I Got News for You' featuring its editor and be reduced to tears of laughter. Being at a live recording of the show is even more powerful. Why is this? Why is the experience and effect so different? Is it just the sense of occasion when I go to a live show or is there something more to shared experience?

We appear to learn more from lectures delivered in person than reading the lecturer's book, or even watching the same lecture recorded on video. Studies show children who are read to by their parents do better than if they are left to follow along with a CD. Two groups of children were tested on two made-up words used in a story. The children read to by their parents had an 80% recall rate, while children who followed the CD only 17%. This is a big disparity. The simplest explanation is that the children who were read to pay more attention. Are there other effects?

IMAX

Most scientists believe communication between humans is classical: words spoken in proximity have no more power than had we carefully written out what we wanted to say. Body language and tone of voice are simply useful tools to aid the transmission of this information. I'm going to explore the ways in which human face-to-face communication might exceed this traditional classical model. Let us look first at the bandwidth of communication between people.

Bandwidth

Let me give you a mental picture for what I mean by bandwidth. Imagine I am sitting in a darkened theatre enjoying one of my favorite comedians at the Edinburgh Festival – the biggest arts festival in the world. I phone a friend who is also a fan and let them listen in. Perhaps I even use the camera and surreptitiously point the phone at the comedian. My live experience is digitized, compressed and transmitted over the mobile network to my friend. He gets the same experience but at much-reduced bandwidth.

My friend has a similar but qualitatively different experience to mine. He cannot hear the degrees of loud and soft I hear, nor the full range of high and low frequencies forming the timbre of the comedian's voice; no sense of the smell of old armchairs or the heat of the audience around me. He is spared the strange stickiness my shoes meet on the floor of the auditorium and the occasional slosh of beer that hits me from a slightly inebriated neighbor. For the person at the other end of the phone, their view is of a tiny two-dimensional screen about 4 by 3 inches square. Of course, they can enlarge the picture, but then the pixilation dominates and it looks like an impressionist picture viewed close up. He has nothing like the same intensity of experience. Loss of bandwidth is something we can study mathematically and the reduction is enormous.

Video and Audio

The image of the comedy show is digitized by the camera and microphone; the video at 384,000 bits per second and the audio at 64,000 bps. Mathematical compression will be applied and the video will shrink to 30,000 while the audio drops down to 4,700. After compression, the whole experience amounts to around 40,000 bits per second. To put it in some perspective, a DVD would be 11.5 million bits per second, nearly 300 times the bandwidth.

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My in-person experience has much higher bandwidth than even a DVD. It may even have infinite bandwidth. Physicists argue whether space-time is quantized but, for now, we will look at what would be needed to reproduce the experience faithfully on modern digital recording equipment.

Digitization

When something is converted to digital form, it goes through a number of steps. First, some way must be found to chop the thing into small parts in space and time. Then each of these parts is sampled with a sensor to give an electrical signal and, finally, this signal is measured and turned into a number.

Old microphones used carbon granules. As the sound waves passed through them, the granules were shaken and made better contact with each other. Connecting a battery across the granules gave a varying voltage. Modern microphones use a variety of technologies. The preference of most recording artists today is the electret microphone. A coil moves inside a magnet generating a varying voltage which is translated into a voltage as before.

Next we use a fast running clock and measure the voltage on each tick giving us a sequence of numbers. We have created a near perfect record of the sound, and we can prove this by recreating the sound through a loudspeaker. This is what happens every time you listen to your iPod.

To digitize film, each frame must be split in space as well as time. On each tick of the clock, a process scans left to right and top to bottom to form a one-dimensional stream of numbers that records the image. The system cuts the picture up into little elements called pixels, standing for picture elements. Each small square has its average color measured for red, green, and blue content coded as a number.

Digitization techniques have become the dominant way electronics work in the home, and digitization circuits are now ubiquitous.

Reality

How big is reality? Setting aside for a moment the problem that it might be infinite, we need to reproduce all the elements that go to make it up.

A normal DVD has an image of 720 by 576 pixels with 16 bits of color depth and a frame rate of 25 frames per second. The eye, however, is considerably better than this and a DVD does not fool it. HD video

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is 1900 by 1000 pixels with 32 bits of color depth and 100 frames per second. This is a great deal better – if you enjoy watching sport or nature documentaries, the additional resolution is amazing. This still falls far short of reality. An IMAX theatre gives a wrap-around image of about 10,000 by 7,000 pixels and comes closer to the average resolution of the human eye, estimated at about 30,000 by 20,000 pixels. But the eye cheats. It concentrates the rods and cones in the central portion of the retina. Although IMAX achieves the average pixel density of your eye, it comes nowhere near the peak density which is nearly 10,000 times greater.

For a truly equivalent experience, we would need about 320 million pixels *per* eye at a frame rate of 120 frames per second, allowing us full stereo synthesis. At this speed and resolution, we are matching the visual acuity of the eye and should be able to fool it completely. But there is one more problem to overcome: The image is not interactive. Move your head in the real world and the image will change. The objects in the foreground will vary their position in relation to the background, so-called motion parallax. Try it now, move your head and you will see that the book, or screen you are reading moves in relation to the background. In a simple digitized 3D image this will not happen. You *will* have a 3D image but you will not have a *real* image, a light field.

To create a real image you need to view a hologram or use head-tracking technology. A hologram records the light waves given off by an object in multiple directions rather than just the intensity of the light striking the camera through a single focal point. When you shine a laser back through the hologram, it regenerates the light waves as they would have originally come from the object. That light can be viewed from different directions, giving the impression of three dimensions rather than a mere two-dimensional photograph. There is often a limitation in viewing angle because the original photographic plate must wrap all the way around an object to capture the full 3D light field, but the illusion is very convincing.

A more effective way to create a real experience – and one with no restriction on viewing angle – is to construct the image in a computer and track the movement of your head. The computer can create the two-dimensional images each eye would see if the scene were truly three-dimensional. Computer software resolves motion parallax and a host of other elements, but to do so the computer must understand a model of the world so it can calculate how the scene would look from a particular angle and in the appropriate lighting. Some recent games such as Activision's 'Call of Duty' do this, and the experience is compelling.

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Hologram

There are still problems. The image is stereo but planar. All the light coming into your eye comes from the screen a meter or so away. In the real world objects need you to change the focal length of your eye to bring them into sharp focus depending on their proximity. Try looking at your hand as you move it towards and away from your face, too close and your eye can't pull focus any further and it will blur. This mismatch between focal depth and the apparent distance implied by motion parallax is one of the reasons you can get headaches watching 3D images. There is something not quite right about them and your eye has to learn a new behavior.

Audio Field

Our poor friend at the end of the phone is listening to a mere 4700 bits per second rendition of the comedian. A compact disk is 64,000, 16-bit samples per second in stereo, over a million bits per second. So the information content of a mobile phone call is very low. It is a miracle you can understand speech at all over such a narrow channel, but this is made possible by two factors. First, human speech uses a limited range of frequencies. All the information in our voices lies within about two octaves centered on middle C. And, second, you can perform some

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clever mathematics to generate speech from seed information. For a given speaker the vowel 'a' might be 20% middle C, 50% F and 25% A, with a few other things thrown in for good measure. We can transmit this information and ask the computer at the other end to re-synthesize it. This is what happens when you listen to someone on a modern phone. You do not hear their actual speech, you listen to a computer synthesizer make a near approximation.

CD is no longer the gold standard for sound. Professional audio has standardized on 24 bit recording which is probably far beyond the limit of the human ear. An audio soundtrack is doing a good job at 2 million bits per second.

Sitting perfectly still in the middle of a room, each ear will pick up a different signal if the source is not directly in front of us. The two ears on a human head face a little forward, and the hair on your head slightly absorbs sound. We can calculate the source of the sound by the slight difference in the times at which it strikes each ear, and the variation in frequency content. We can use these two pieces of information to determine the direction from which a sound is coming. It was useful for our ancestors to be able to tell where the saber-tooth tiger was hiding. We can gain more accurate information by turning our heads from side to side. The differences in frequency and timing should vary as we do so and we gain a little more data to perform the calculation. If we walk through the room we sample yet more of the soundscape and this can be used to pinpoint the exact location of the source. As we move, we expect the sounds we hear to change subtly according to the mental model we use for locating objects in the soundscape.

To give the illusion of a soundscape modern systems use multiple microphones to capture the sound, so it can be reproduced on multiple speakers. Ideally, we would record a hologram of the sound but it is possible to record on thirty or so microphones and mix the tracks down to 5 or more channels giving us the sound experience we now expect at a modern cinema.

What is the Bandwidth of Life?

We have not yet talked about the other senses; smell, vibration, temperature, balance, wind chill, and touch. In all, there are over 25 senses that must be stimulated accurately to simulate reality. Just think for a moment how much information must be replayed to reproduce the sensation of bungee jumping off a bridge in the jungle or taking off into

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space, or giving birth. To digitize life completely, we need to stimulate every relevant nerve ending in the human body in real-time – skin, ears, eyes, balance, pain centers, and so on.

At the low end, a 'perfect' IMAX production would require 360 degree stereoscopic projection and the generation of a full sound field. This would take 3 Gigabits per second for the audio field and 5,600 terabits per second for the video field. This could be substantially reduced if the person wears virtual reality glasses to track their head and eye movements, but then you are substituting resolution with computer power.

At the high end, a team at the US Department of Energy's Fermilab estimate reality needs one hundred trillion samples per inch for a 'simple' quantum representation. If we look at the many worlds view of quantum mechanics, each photon hitting our eye can't be fully described by a single number. The photon may be entangled with other realities we should keep track of. This causes our picture of reality to become wildly complex. Everything we might see and experience is in some way a combination of possibilities, and these possibilities all interact. Real life is *very* complex.

Symbolic Communication

Computers have no concept of an in-person meeting. They communicate using purely symbolic methods in binary numbers. These have the same meaning whether communicated over a short piece of wire or using a fiber optic cable half way around the world. Computers never have to communicate understanding to each other because they use programs and a program can be perfectly transmitted. Body language is, of course, completely alien to them!

We know there are non-computable things; functions, numbers, musical melodies, and mathematical puzzles. Why would there not also be a place for non-computation in communication? David Deutsch has suggested human creativity is used to guess the 'program' running in someone's mind, and evolved so we can learn skills. Instead, might face-to-face communication be important because it lets us impart knowledge in a non-symbolic manner?

Hyper-communication

As with hyper-computing, hyper-communication is controversial. We instinctively know human communication is very different to computer communication. Face-to-face communications have a qualitatively

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different feel to them. My question is this. Is there more to face-to-face communication between human beings than the simple exchange of symbolic information?

Let us propose an experiment. I erect a 3D screen with a hi-fi surround sound system in a university lecture hall and deliver a lecture to a camera in the adjacent hall. Half the students see the lecture directly, and half remotely. With modern screens, it might be possible to set up the experiment so well that is difficult to tell which hall I am actually in. Is the experience of the remote students the same as the ones sitting in direct proximity with me? Do mirror neurons fire more strongly and pick up more information when you see me in the flesh, or is the feeling that a lecture is better when you are 'physically there' an illusion? You are perhaps less likely to fall asleep in my lecture if you are physically there because you are afraid I might walk over and hit you! What possible non-classical effects could be in play when you see an event or communicate in person that might make the communication different? Here are two potential differences:

Information in a face-to-face encounter is continuous, not digitized. Continuous information is infinite in nature and does not have the finite limitation of digitized data. Of course, if we have digitized the sound at 24 bits and replayed it with extreme fidelity, there should not be any loss in information, but the interactivity of the soundscape is hard to simulate.

Light entering your eye contains information that could be quantum entangled with the object you are viewing. You become part of the system rather than merely an independent observer. It is difficult to see why this would produce a different quality of communication but it is testable. Set up the lecture experiment and measure the quality of understanding communicated between the parties.

If we believe our brains are super-Turing, then considering there might be some similar effects involved in human communication is not unreasonable, perhaps quantum effects play a role in communication. If we conclude our brains think classically, then we *probably* communicate classically.

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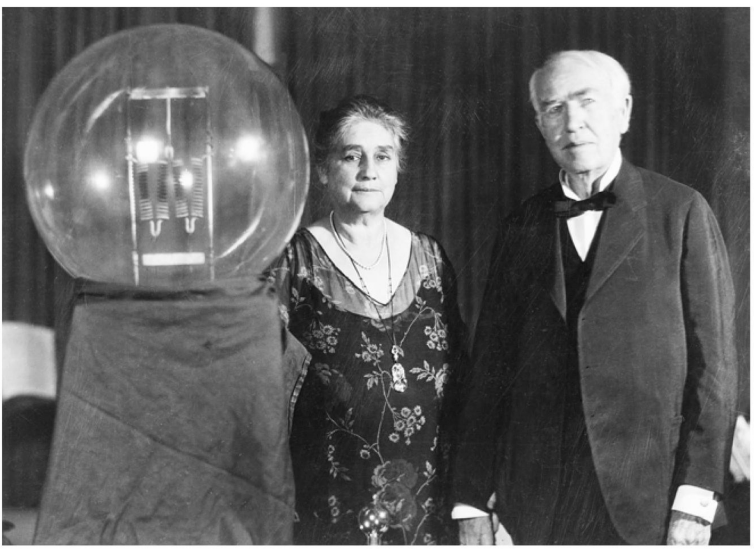
Chapter 14

CREATIVITY



Thomas Edison, his wife and a Light Bulb

"Creativity is allowing yourself to make mistakes. Art is knowing which ones to keep."

Scott Adams

"Invention is 1% inspiration and 99% perspiration."

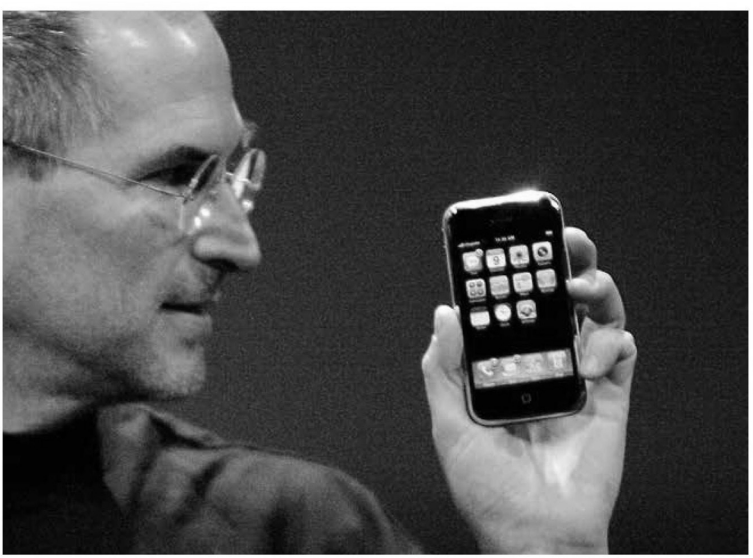
Thomas Edison

"Creativity is just connecting things. When you ask creative people how they did something, they feel a little guilty because they didn't really do it, they just saw something. It seemed obvious to them after a while. That's because they were able to connect experiences they've had and synthesize new things."

Steve Jobs

The ancient Greeks believed there was no such thing as creativity. Our job, as humans, was to look at the earth and discover things about it. When we looked at light passing through water or built a boat to travel on it, we were discovering, not inventing. Shipwrights did not invent boats they were simply building inevitable forms. Everything there was to know already existed, we just hadn't realized it yet. Of course, Greek playwrights were busy 'creating' the first plays; tragedies, comedies and the like, but serious thinkers thought of them as documenting the human condition. It wasn't until the Renaissance, 1500 years later, that humans began to appreciate that they *create* knowledge, and this started us on our quest to understand creativity.

One of my childhood memories is sitting on the kitchen floor with a glass of water and surrounded by knives and milk bottles. I was trying to solve one of the problems from Edward de Bono's book on lateral thinking, *A Five-day Course in Thinking*. De Bono, now in his 80s, is a prolific writer with over 60 publications to his name – all aimed at making us more creative. His books pose a series of practical problems, each needing progressively greater creative intelligence. The particular problem I was trying to solve was to balance a glass of water on knives suspended from four milk bottles. It took me after 2 hours.



Steve Jobs shows the iPhone

Except for De Bono there is not much written about creativity in books or on the Internet, but if you dip into the video archive, the discussion really opens up. Perhaps this is a feature of creativity; it's easier to explain in person. Of course, I have taken on the writing task with this book but I have the benefit of modern day resources such as multimedia, interactivity, and the web.

Some people appear to have creativity in abundance and the things they create are truly wonderful. I'm thinking here of Picasso, Einstein, Mozart, Edison, or Maxwell, but a precise definition of creative thinking is hard to pin down. Here are some generally accepted categories:

Divergent Thinking

The first sort of creative thinking we recognize is divergent thinking, often called brainstorming. This is the art of coming up with ideas – lots of them. A quick way to test your skill is to take a minute, and list all the possible uses for a paperclip. Try it!

In 60 seconds write down all the uses for a paper clip you can think of. Time yourself.

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ANSWER WITHOUT READING ON

This is the classic test of creativity developed by J.P. Guilford in 1967. It is called the Alternative Uses Task. You can try the task with many objects: bricks, chairs, even water. How did you do on your first attempt? 8 to 10 uses is about average, 20 is extremely good. It's possible to teach most people to get near twenty and I'll show you how to do this in a moment.

Another test of idea generation is to draw 30 things in 30 circles. Thirty is such a large number it forces us to come up with some nutty ideas and break our natural tendency to self-censor.

For example, I'd like you to create logos or logo ideas, for a new coffee company in your circles. The test is best done without a time limit so now is the time to break off reading and make yourself a coffee. Then come back and draw 30 circles on a piece of paper. Fill in the circles.

MAKE A COFFEE, THEN START DRAWING.

The aim of brainstorming is to remove our inhibitions and get us to generate a mass of ideas. In normal life, we tend to suppress ideas even before we are consciously aware of them. Sir Ken Robinson has researched creativity in children and found the ability to brainstorm reduces linearly with age. At five or six, children given one of these divergent thinking tasks come up with many creative solutions: fold the paper clip into a dinosaur, and use it to attack your friends, get two and use them as chop sticks. As adults, we tend to disqualify ideas. You could never fold a paperclip that tightly or accurately, we said, "a" paper clip not two. But, you *can* fold a paper clip tightly, and the room you are doing the test in has thirty paper clips and thirty people in it so just team up with a friend. I never said this was a solo task!

Do you see how you impose nonexistent rules on your thinking, particularly the implied rule of not working with others? I did not say this test was subject to examination conditions. The first twenty years of our lives teaches us to work alone on intellectual tasks, yet when we get to the workplace we can, and indeed must collaborate to succeed. Now you have an idea how to ace the paper clip test: don't censor yourself and don't imply rules I have not imposed!

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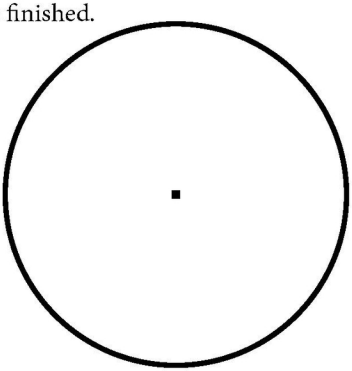
TRY THE PAPER CLIP TEST AGAIN!

Divergent thinking is rarely the final goal; it is rather a jumping off point for the creation of something new, like a solution to a mathematical puzzle, a painting, or a novel invention. The exercises allow us to explicitly see one of the early creative steps – idea generation before the pruning step. But most creative people often just create, they don't follow a scripted process. The term 'the creative process' is a great misnomer. There is no process that actually creates. Process merely puts us in the right frame of mind to do so. Processes are useful for framing a problem and ensuring we have all the right tools at our disposal: good crayons, some nice art paper, a hot cup of coffee. But process must be put to one side at the moment of actual creation.

Convergent Thinking

Convergent thinking is the opposite of divergent thinking. It focuses on discovering the final solution to a problem rather than generating precursor ideas. Some creative people only use this method, avoiding laborious processes such as brainstorming.

Tests of skill for convergent thinking generally pose puzzles where there is only one correct answer, but one that requires a non-linear step. Here's a really simple convergent thinking puzzle to try. It only requires a piece of paper and pen. Draw a circle on a piece of paper with a dot in the center. It should look like this. Do NOT take the tip of the pen off the paper until you are finished.



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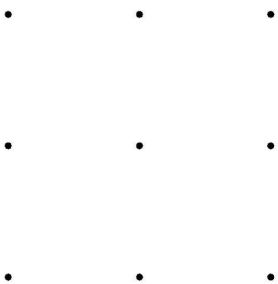
TRY ANSWERING IN YOUR OWN TIME

Another famous, but clichéd, problem is of you to draw four straight lines through these nine points without lifting the pen from the paper. Can you do it?

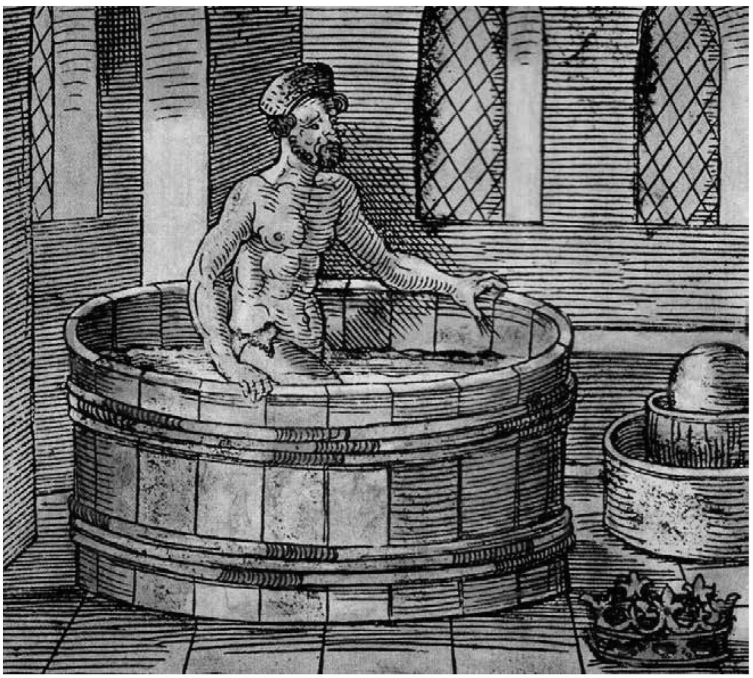


TRY ANSWERING IN YOUR OWN TIME

I won't put the answers here, or even a hint. It's quite famous and many of you will be familiar with them. The answers are buried on the website, and for those of you who already know the solution, there are some alternative problems. If you can't immediately solve a problem, think about it overnight. It's worth seeing what your brain will do while you are asleep!

The Science of Creativity

The first person to theorize about the creative process was Graham Wallas, the co-founder of the London School of Economics. In his book *The Art of Thought,* he proposed a five-step model for creative thinking. First preparation, when you become fully acquainted with the problem and its domain. Then incubation; walk the dog or make a cup of tea. After the meditative incubation phase you may get a gut feeling that a solution is on its way. Wallas called this third step intimation. It's left out of many modern versions of his theory, but I think it's an important step. Shortly



Eureka

after this you get that Eureka moment – illumination or insight where the creative idea bursts forth into your conscious awareness. The idea must finally be verified. Many of our ideas will turn out to be mistakes, but that's part of creativity. In the nearly hundred years of investigation since Wallas proposed this theorem, we have not moved much further forward in understanding creativity.

Alan Turing described his thoughts on the science behind creativity in a short piece he wrote about decision making:

> *"When making a decision of minor importance, I have always found it advantageous to consider all the pros and cons. In vital matters, however, such as the choice of a mate or a profession, the decision should come from the unconscious, from somewhere within ourselves. In the important decisions of personal life, we should be governed, I think, by the deep inner needs of our nature."*

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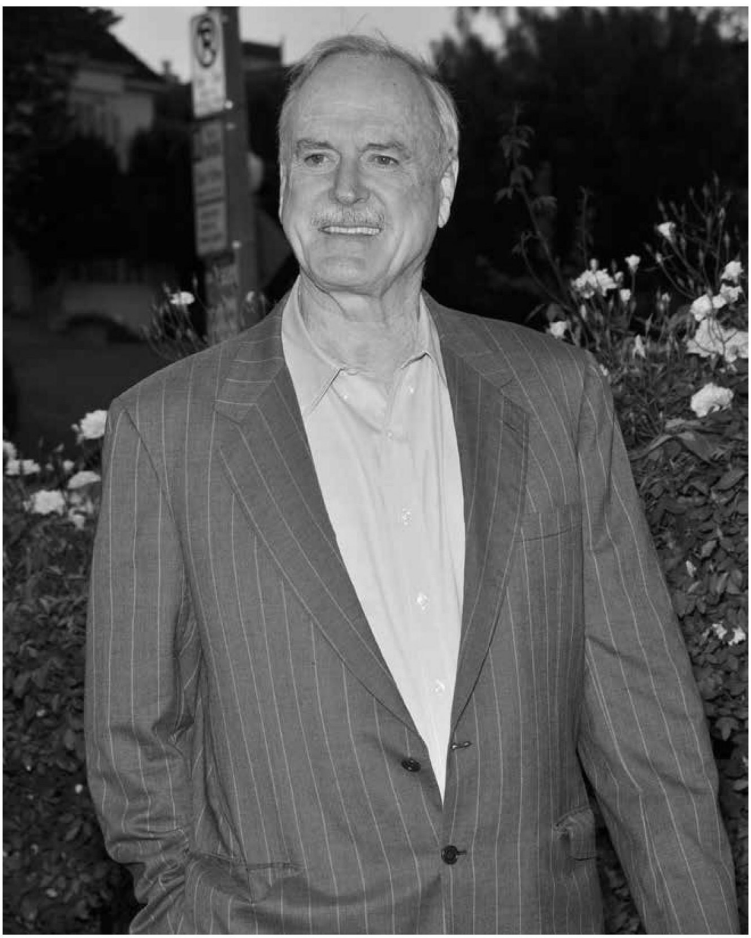
Later in his career he came to believe machines would become intelligent and this sort of intuitive thinking could be effectively performed by a computer. As you know, I don't agree with his later viewpoint.

Another person who has thought long and hard about creativity is John Cleese, the comedian and actor. He describes the process wonderfully in a number of talks which you can find on YouTube. He finds a lot of his creativity emanates from his unconscious rather than conscious thought processes. To optimize this he needs large uninterrupted blocks of quiet



John Cleese on Creativity

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time. Often, if a problem seems impossible, he will sleep on it. When he wakes the next morning, he will frequently find the problem has solved itself and a solution is ready at hand.

Art

The final class of creative thinking we generally recognize is artistic skill. This is probably a form of convergent thinking, except both the problem and the solution are open. Good artists are considered highly creative and most people tend to agree on what constitutes good art. There are some arguments but they are usually more about genres. I might not appreciate modern installation art, even to the point of declaring it, "not art." But, when forced to ignore their prejudices most people tend to agree on the distinction between good and bad.

Painting, sculpture, music, architecture and poetry are the traditional fine arts. There is often some argument over architecture: is it not too 'functional' to be considered an artistic endeavor? After all, art is not supposed to have any purpose other than to be, well, art. This definition inevitably leads to arguments about whether bad art is still 'art'. Art should be artful and how do you arrange a pile of used tires artfully? But this is a very narrow definition. I prefer to define art as something that provokes an emotional response in the beholder. Using this definition, the fact that a pile of tires disgusts and annoys you is exactly the point. Perhaps a more 'enlightened' viewer than you is intrigued by the clever use of materials.

Regardless, we consider art to be a creative endeavor and we can measure it using the criteria of novelty and quality. Since most people agree on these measures for a given piece of art, we can use the wisdom of crowds to give us a scientific scale. That does not mean there won't be art that you love but which leaves me cold. That is the joy of it. Novelty and quality are not the same as joy and pleasure, far less the tingle factor.

A quick test for artistic skill is to take a pen and paper and turn to the person sitting on your left and try to sketch them.

TRY IT!

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If you tried, you and your neighbor would probably find the results rather humorous. But, most likely, you did not follow my instruction. This is a form of social self-censorship. I asked you to do something rather difficult and embarrassing, but very creative and likely to enlighten you. Sadly most people – I am no exception – tend to censor their creativity for fear of embarrassment. Children, of course, do not sensor themselves as much as adults.

Now you know how to be more creative. Find your inner child and don't censor yourself too much!

What Sparks Creativity

As an inventor, I'm often asked what makes me creative. How do I do it? The answer is, I have no real process. After all, a process is mechanical and this entire book has been about exploring how creativity is a non-mechanical task. However, there are many things you can do to unleash your creative potential.

New ideas are often sparked through linking disparate ideas. Expose yourself to as many ideas as you can, read widely, attend conferences, visit customers.

Creativity requires peace and quiet. I personally get up early every morning. This gives me a good two hours of uninterrupted time every day. It's also the part of the day when my brain works best. Others prefer to work late into the night.

Pressure, for me and for many people, is a great incentive. Tales of the Polish Enigma code breakers, Douglas Adams' writing deadlines and the fear of impending death in shark attack stories all force people to think in an accelerated way. This appears to help many people defeat the human tendency to prevaricate.

On the other hand avoid panic. While a level of pressure can help, panic is unproductive. There is a sweet spot between having enough time to get properly acquainted with a problem and an impending deadline to force the crystallization of ideas. This balance varies from person to person and is something you need to test for yourself.

You need time off. Once you have a well thought out idea, you may need to leave it alone for a while to allow your subconscious to work. Time off does not need to be two weeks at the beach. Charles Darwin and Benjamin Britten used to go for long walks. You can walk in Darwin's footsteps at Down House in Kent. Others such as John Cleese

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like to 'sleep on it'. Stephen Hawking distracts himself by working on a different problem for a while. Anything that avoids focusing directly on the problem itself seems to allow our creative freewheel run.

Environment can be important. The campuses created by Steve Jobs for both Apple and Pixar are designed to foster creativity. The physical environments build team behavior but also cause people to bump into each other. Cross-pollination drives creativity.

There are also some myths to dispel about creative people. Inventors are portrayed as eccentric and hopelessly disorganized, but Feynman kept notes of every idea he ever had. I have kept a series of notebooks, now computer based, since I left university. I still have almost all of these on a shelf at home. Creative people may be a little mad, but the successful ones are rarely disorganized.

You must allow your brain to free wheel. J.K. Rowling has said the characters in the *Harry Potter* novels write themselves. I come to my computer each morning having *not* thought too much overnight and just write. Creation is just that; you must allow yourself to do it. It's not a process.

The Innovator's Dilemma

Why don't big companies create? In 1997, Clayton Christensen of Harvard Business School wrote *The Innovator's Dilemma*, the seminal work on creativity within organizations. In it, he shows us why established companies tend not to innovate and why startups exist. Christiansen's academic research examines how companies handle discontinuous change in technology, focussing on the hard disk industry.

You might not think this a very sexy sector. Microprocessors and game consoles would be more fun, but the great advantage with the hard disk is there is a single industry journal that has tracked the progress of every player over 30 years, collecting detailed annual data on every facet of their business. For an academic, this is gold dust.

IBM invented the hard disk drive in their research center near Winchester, England. The first prototypes were, consequently, called Winchester Drives. When Christiansen examined the industry, he found something very strange. As the size of disks reduced first from 8" to 5¼" and then from 5¼" to 3½", the dominant players in the previous era went out of business and new startups colonized the market. This fallout was not confined to a few small companies. It affected large, well-established, publicly-listed organizations, too. They failed en masse at each discontinuity. At first this made no sense to him. Surely a skilled

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Hard Drives

hard drive manufacturer would be the obvious group to construct the next generation. But it seemed that not only did incumbent players *not* construct the next generation, they ran their businesses into the ground while ignoring the technology discontinuity. Despite their legions of Ivy League graduates and business school MBAs, they all went bankrupt.

As he looked around the economy, he found a similar pattern in other sectors. Minicomputer companies failed to make the jump to personal computers. Further back in time, buggy whip companies – in the Fortune 100 at the turn of the 20th century – failed to make the transition to the motor vehicle economy. The only exception he could find was IBM. IBM had successfully navigated some transitions but at that time was fighting for survival as companies transitioned from mainframes to Linux based servers and their survival was in question. Why was this so?

Christensen's conclusion is that established companies tend to concentrate too much on their existing revenue streams while ignoring potential new ones. This is no surprise. When the disc drive industry made the move from 8" disks to 5¼", the only customers for these new new smaller models were unheard of manufacturers of personal computers. Some were based in the dorms of MIT and Harvard – Dell and Compaq – not in the existing powerhouses of computing – Digital

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Equipment and Wang. New technology often underperforms the existing forms. 5¼" drives were slower, less reliable, and cost more per bit than their 8" predecessors but, of course, in one respect they were better. They were smaller and lighter and could fit in portable computers. The new technologies did a different thing in a different way, and overcame their disadvantages later. This chain of events is repeated many times over: Yellow Pages overtaken by Google, Borders by Amazon, Blockbusters by Netflix. Disruptive innovation changes the rules of the game as well as the pieces in the game.

Christensen's advice to companies is to separate your innovators from the existing business because their priorities will differ too greatly. Modern companies build entirely new divisions to create new products, or set up innovation labs to incubate ideas that would otherwise never get enough resources.

Reward for Creativity

There's no doubt society values creativity very highly. One of the first tasks Thomas Jefferson undertook when he became President of the United States was to set up a patent system. He remained head of the patent office for over ten years. These days, the protection of creative

Harold Cohen, Computer Art

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ideas through patents, copyright, and trade secret is big business and combines to form the practice of 'intellectual property'. Societies with the best protection of intellectual property are often the most successful. The USA is the unassailed leader, with Asian countries rapidly catching up. Poor old Europeans have struggled with an almost unworkable patent system for nearly 30 years; a genuine Europe-wide patent only came into effect in 2013.

Creativity in the economy is now extremely important, and nothing emphasizes the point more than the job market. During the 60s finding a job was easy. There was an almost unlimited range of mechanical jobs on offer. In the post-industrial age, almost all the mechanical jobs have gone. Today we need to be experts in a field, able to solve problems creatively. You can't expect to walk into a job and be profitably productive on the first day. Finding a job is harder and the cost of employing someone is greater.

Why did we Evolve Creativity?

Roger Penrose wonders why mathematical creativity evolved in humans since it only became useful in ancient Greece a few thousand years ago. He believes it must have been useful for something before this. But what?

David Deutsch thinks creativity developed to allow one human to understand the thoughts of a fellow human being. We can't precisely communicate the 'programs' we run in our heads. We are unable to download a detailed thought and put it on a memory stick. He thinks our creative capacity developed to help us pass skills from one to another. The ability to paint and sculpt is an accidental by-product of this adaption.

It's my view we evolved creativity to deal with new situations and puzzles in our daily lives. We use creative thought processes and ingenuity to come up with novel solutions for when we can't rely on programming or a store of rules. Otherwise, the very first unforeseen situation could kill us!

Computer Creativity

Humans find creativity difficult. It requires peace and quiet, detailed study and input of caffeine. How does a computer fare? I have argued that computers cannot be creative above the logic limit, so this does not preclude them from creating within the narrow confines of a particular solution space. But a human still needs to set the rules for this space. The level of creativity we should see from computers is convincing within

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a limited conceptual area. Computers are not going to wake up one morning and *decide* to compose a breathtakingly beautiful symphony, but if we give them rules they can make a convincing version.

Many computer systems have been designed to tackle creativity. We have already met the composer Emily Howell and Douglass Hofstadter's computation program. Here are two more examples: Jape and AARON, which create jokes and art, respectively.

Jape – Joke Analysis and Production Engine – is a program created by Graeme Ritchie and Kim Binsted. It generates puns, the sort of things you might find in an English Christmas cracker or children's joke book. I'll let the output speak for itself.

> Q: "What is the difference between leaves and a car?"
> A: "One you brush and rake, the other you rush and brake."

> Q: "What do you call a spicy missile?"
> A: "A hot shot!"

One of the most enlightening examples of computer creativity is AARON – refreshingly not an acronym. His machine is depicted here and you should look up some works on the web, such as *Adam and Eve*, and *Aaron's Garden*. The program encodes rules about figures, objects

AARON – Harold Cohen, Automatic Painting Machine

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and perspective. Once coded the program takes off and is remarkably creative in its compositions, without any further human intervention. However, each new capability must be hand-coded by its creator, Harold Cohen. These paintings give a good visual interpretation for the sort of latitude imposed by the logic limit. AARON can do some very impressive things, but always in a mechanical – albeit beautiful – way, within the rules set by Harold Cohen, the true artist. AARON will not suddenly awake one morning and independently decide to experiment with the color blue!

To give an idea of what I mean by 'mechanical elaboration' in a musical context, imagine you were using a Casio synthesizer. These machines have all sorts of fun settings. You can program them to play drum tracks, fill in chords, and add a jazzy, syncopated harmonization to your melody. But none of this is truly innovative. It's mechanical elaboration of your artistic material. Jape, AARON and Emily Howell all do the same thing within their domain. They mechanically elaborate the artistic creation of their human masters. AARON does an extremely good job of this.

The Myth of the Design Tradeoff

An important consequence of the non-linearity of creativity is we are not constrained by tradeoff laws. Let me explain.

Volkswagen Polo

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How often do you hear the phrase, "It's down to tradeoffs," or "It's a matter of priorities", or even "You can't have your cake and eat it."

These stock statements misunderstand the infinitely complex nature of creativity and problem solving. Let us take a concrete example: the car.

My first car was a Volkswagen Polo. It was a great little car, quite nippy, cassette-radio, and four seats. The most recent Polo has antilock brakes, airbags, NCAP 5-star crash resistance, smarter styling, and a low emission engine. Shall I go on…? The doctrine of tradeoffs says I would have to give up something to gain these new features. But, I have not. The newer Polo is cheaper in real terms than my original, as well as being better designed.

Problems always have at least two dimensions of freedom. We can trade one feature for another or we can innovate to both have our cake and eat it! We are never constrained to simple on-the-one-hand, on-the-other-hand type decisions. Creativity is unconstrained by linear rules and tradeoffs.

Process versus Creativity

How many times have you heard the words, "We must create a process for this!"

In its place, process is good; It makes things consistent, repeatable and predictable. You can follow a process by rote without error. Processes are also easy to document and communicate because they are symbolic. But process is limited. It is, after all, a set of prescribed rules for solving a particular problem – and, because of this, it falls into the same trap.

A process cannot solve a problem that requires creative thought or logic more complex than the logic limit. Logical processes are useful for tracking lists. I am reassured when I get on an airplane and know the pilot has been through a preflight checklist. I would not want to fly in an airplane where the pilot announced he was taking a creative approach to the preflight check.

Process is a perfect tool for organizing the steps around being creative, but it won't do the creating for you.

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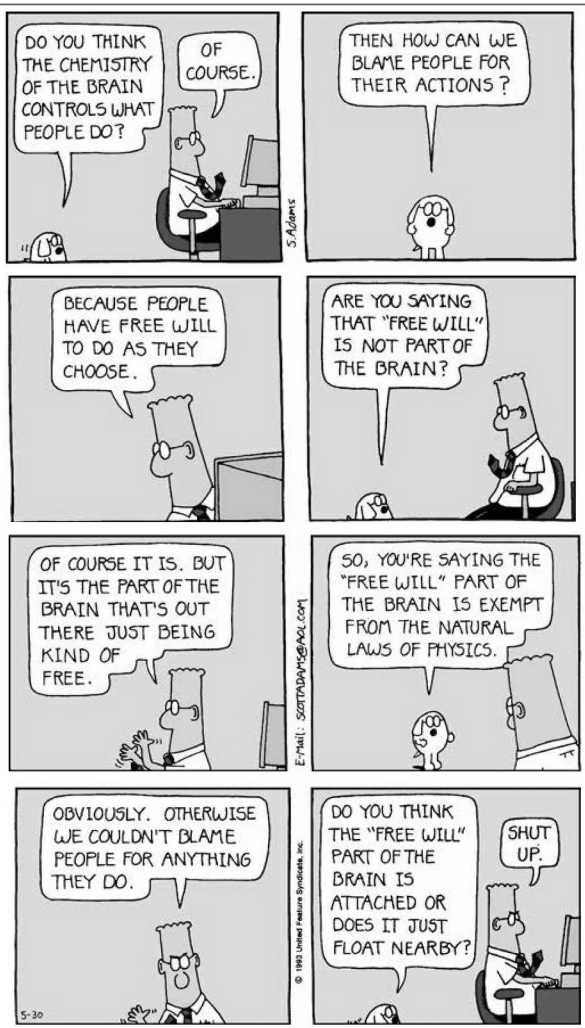
Chapter 15

FREE WILL



Dilbert Ponders Free Will

*"We have to believe in free will -
we have no choice."*

Isaac Singer

*"Time really is an illusion -
lunchtime doubly so."*

Douglas Adams

A child grows up in poverty, their father absent, mother a drug addict. Riots break out and the child defends the local convenience store. Another child born on the same road, but from a better background, loots the store and is arrested. This scene played out on the streets of London during the summer of 2011, but similar incidents happen all across the world. People choose different moral paths; one person makes a good decision; the other, a bad one. Did they make these decisions freely or was their behavior inevitable, dictated at the dawn of time?

Free will is at the heart of our justice system. It requires a crime to be intentionally committed by a person of sound mind. If I kill you in an accident or because I am mentally incapacitated, I am innocent. Of course, if I mentally incapacitate myself with alcohol I would be guilty of manslaughter, perhaps even murder.

Our justice system requires a crime to be intentionally committed by a person of sound mind. Whenever we see something bad in the world we trace the events back to the thought processes which led up to it. It seems we punish the decisions in our brains leading to a crime, not the crime itself. But, in a deterministic Universe my thoughts could never be at fault. They are inevitable. "The Universe made me do it!"

You need not worry about the fabric of society falling apart in a deterministic Universe. The whole of existence will play out according to a predetermined script, complete with lawyers, trials, drama and pathos. The judge, jury and executioner would also have no free will. It would look as if you paid the price for the choices you made, but this would be an illusion. The whole thing would be like one enormous screenplay.

The concept of determinism goes against our conscious experience. We all have a strong sense of free will. I certainly think I have it! And this presents a problem, because the classical laws of physics say our Universe is entirely deterministic, and that free will is an illusion.

I should briefly mention 'compatibilism', a branch of philosophy that claims determinism is *not* at odds with free will. It argues that if I feel free and my actions do not appear constrained, then I am free even though my future might be inevitable: a sensation of freedom is sufficient. This seems rather feeble. I am seeking an explanation for how we might be truly free to choose our actions, not some linguistic trick to argue freedom is subjective. I believe true free will is a physical principle with observable effects on the Universe that would not be seen in a determined one.

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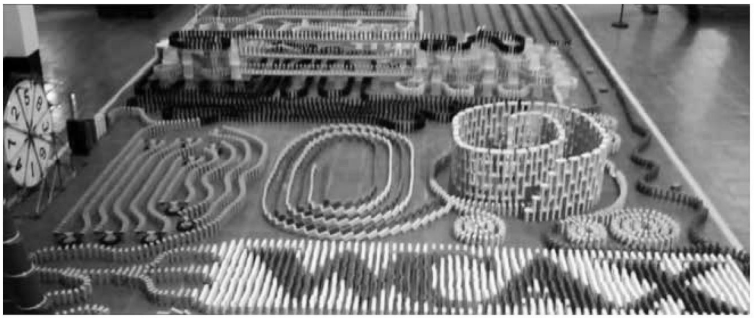

Domino Toppling

Determinism

To firmly grasp the idea of determinism let's look at a fun example, domino toppling. If I arrange a set of dominoes on their edge in a long line and push over the first it will fall, knock over the next, then the next, and so on until all the dominoes have fallen. It is inevitable, and fun to watch. The same is thought to happen with particles in our Universe, albeit at a much smaller scale. The laws of physics governing these particles describe precisely what will happen as they interact. Our Universe could be thought of as a mechanical clock, wound and set at the Big Bang, or a fractal equation generating the wonders we see around us.

When I push over the first domino it should be possible to capture all the information about the particles in the dominoes, my hand, the table, and the surrounding environment to precisely determine what will happen next. Will all the dominoes fall perfectly, or is there a break in the pattern – one domino just a tiny bit out of alignment – which will spoil the fun? All the information is there in front of me and I should be able to predict it perfectly.

The laws of physics, as we understand them, are not only deterministic, they are reversible. This means if we know the position and momentum of every particle in the dominoes and the surrounding environment, we can extrapolate their motion back into the past. It should be possible to trace back the path of each particle to reconstruct the past history of the dominoes.

If we were to cast a wide enough net, and collect all the available information, we could go back and see the events in the factory where the dominoes were made, or even see the trees that was felled to make them. We would need a *lot* of information and huge computing power, but we *could* do it! With a sufficiently powerful computer we could travel

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back in time, albeit as a simulation, and relive past events. This would have no effect on the events themselves as it would be like watching a movie, but we could see every aspect of the past from any viewpoint.

To perform this time travel trick for real, we would have to gather information from an enormously wide area. Information spreads out at the speed of light. One minute after the dominoes topple, the information about the event will have spread one light minute – that is over a sphere forty-million kilometers across – half way to Venus. An hour later and it would be outside the solar system. If you were to cast your net that wide, and gathered up all the information within the sphere, you could still perfectly model the moment when the dominoes were toppled. The wider you cast the net, the more information you have and the further backward in time you can travel. If you take the idea of collecting information to its logical conclusion you could gather all the information in the Universe at a moment in time.

In 1814, Laplace put this idea in an essay. He proposed an immensely powerful being observes the position and momentum of every particle in the Universe. Armed with *any* snapshot of the Universe and the laws of physics, the entire future and the past of the Universe. The being was nicknamed Laplace's Daemon and the idea has influenced philosophy ever since.

If the Universe is predictable, our concept of time needs to be rethought. A common sense notion is that things in the future are unknown and things in the past are known. But, in a deterministic Universe a daemon or a supercomputer could keep track of all the information and tell you what is inevitably going to happen. The conscious feeling we have of moving through time would be just an illusion. Past and future have no meaning and there would just be a solid, permanent block of space-time. If you stood outside the Universe and looked at this block of space-time, everything that is going to happen and has already happened is set. This is sometimes called the Block Universe Hypothesis and is the logical conclusion of any theory that imagines an entirely determined Universe.

One thing that seems to throw doubt on this Block Universe Hypothesis is our personal conscious experience of the world. We experience the Universe unfolding over time. (Of course, we could have this conscious experience in a determined Universe if someone had programmed it that way. All we can say is that it seems unlikely someone would go to the trouble of giving us a completely fictitious experience. There are an infinite number of possible Universes, why pick one where we think time flows, but it does not.)

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Uncertainty

If you know a little of quantum mechanics you might imagine Heisenberg's Uncertainty Principle comes to our rescue.

Heisenberg's principle is often misunderstood. People sometimes try to explain it as an experimental problem. If I want to measure the position of a particle I am going to need to shine a light on it. The photons I use to illuminate the particle will knock it out of position so the act of measurement disturbs the system. This is *not* the Uncertainty Principle. It is a different but related effect, called the measurement problem. The muddle is really Heisenberg's own fault. When he tried to produce a layman's explanation he used the analogy of disturbing the particle with the photon. This is wrong. A photon would not disturb a particle enough to explain the uncertainty we find; particles are fundamentally uncertain even before we measure them. Heisenberg's Uncertainty Principle is a quantum property, which means it makes no sense and there is no analogy I can give you to properly explain it! Here is the closest thing I can find.

Imagine I am playing a musical note on a guitar. You might want to know two things about it; where exactly is the string and what pitch, or note, am I playing? The problem with these two measurements is they can't be stated at the same time. Pitch is dictated by the rate of oscillation over time: the number of times a string vibrates back and forth per second. Position is the exact location of the string at a given moment in time. If I state the position precisely this has no pitch because pitch needs a time interval. If I allow a time interval the string will move during that time and it won't be precisely in one place. The best I can say is the string is about two millimeters above the fret board and two-thirds of the way across it.

So, I hear you cry, this Uncertainty Principle means our Universe is not deterministic because it is uncertain.

Unfortunately, the principle only prevents *us* from measuring the position and momentum of a particle at the same time, it does not prevent the Universe *knowing* the information it needs to allow the particle to go about its business in an entirely deterministic fashion. There is a perfectly reliable and predictable wave function that governs the motion of every particle, just as there is an entirely predictable equation for the motion of a string on a musical instrument.

If both the classical and quantum laws of physics are deterministic where does the freedom come from to make our Universe non-deterministic? There is just one place to look: you and me.

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The Observer

I am looking out of my office window. It is a sunny autumn day and I have a beautiful view over London, but if I squint a little I can also see my reflection. The window in front of me is not perfect. Although it is mostly transparent, the glass also reflects some of the light. If you think of light as particles, the majority of the photons go through. But some bounce back. I'm going to show you that the behavior of these photons is governed by the observer – me!

The laws governing light, and most of the strange and wonderful effects it has, were first stated by Isaac Newton. Newton was an extraordinary man. He discovered many of the physical principles we use today, and his view of the Universe reigned unchallenged until Einstein's discovery of relativity. He was also, by many accounts, a nasty piece of work. Not only was he a famous academic, he also head of the Royal Mint. He is said to have taken great pleasure in having forgers hanged on Tower Hill. He claimed the invention of differential calculus despite it being invented independently by Gottfried Leibniz. Newton managed to have himself appointed to chair the committee reviewing Leibniz's work and determine who had come up with the idea first. Unsurprisingly, the committee found for Newton!

We see Newton's laws of reflection and transmission in all manner of everyday products, for example, the antireflective coatings of camera lenses or the screen of your smartphone. Manufacturers cover the glass in these products with coatings just a few molecules thick. Interference between the layers *kills* the reflections. On a very expensive lens several different layers are used; some kill red light and others kill blue light. Together they suppress most of the reflection. If it were not for these coatings you would be unable to go to the park on a summer's day and read your iPad. We need to think about reflection and transmission to demonstrate our role as observers.

A windowpane has two surfaces. Both surfaces reflect light, and if you look closely you will see your face is really reflected twice. You might think this is simply a double reflection but this is not so. Light behaves like waves. As with water waves, they interfere with one another. If two light waves are at the top of a crest as they meet, the result is a crest of double height. If both are at the bottom, you have a double trough, and if one is a crest and the other a trough you get nothing as they cancel each other out. You can see this effect in waves on the surface of a pond.

When light strikes a window pane, the light has two chances to reflect: one from the front surface and the second from the back surface. These two reflections interfere with each other. And, again, when you

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Wave Interference

have interference you sometimes get constructive interference – the double crest or trough – and sometimes destructive interference – the crest and trough canceling each other.

The reason we don't see this effect in every reflection is because of imperfection. Windows are not perfectly flat and light is multicolored, so the effect is hard to see. But it is definitely there, and if you look really hard at a reflection in a window, you can sometimes see it at the boundary of sharp objects. The effect is very clear in the next picture which has been set up with two flat pieces of glass resting against each other. There is a tiny air gap between them. It is also commonly seen on puddles in cities. In this case the puddle usually has a slight film of oil on it. Unlike glass, puddles are perfectly flat thanks to gravity, but the oil film is thick in the center and thin at the edges. The light reflecting off a puddle will show a rainbow of colors. This is because each color is giving us a pattern of light and dark. If you look at the same puddle at night in a yellow streetlight, you will just see a monochrome pattern of light and dark. Look at the picture of waves on a pond.

The patterns of light and dark are usually explained by imagining the photons interfere with each other. This explanation is insufficient. Imagine for a moment you can see as well as a frog, and perceive one photon at a time. One moonless night just one photon comes to the two glass surfaces and reflects. What happens?

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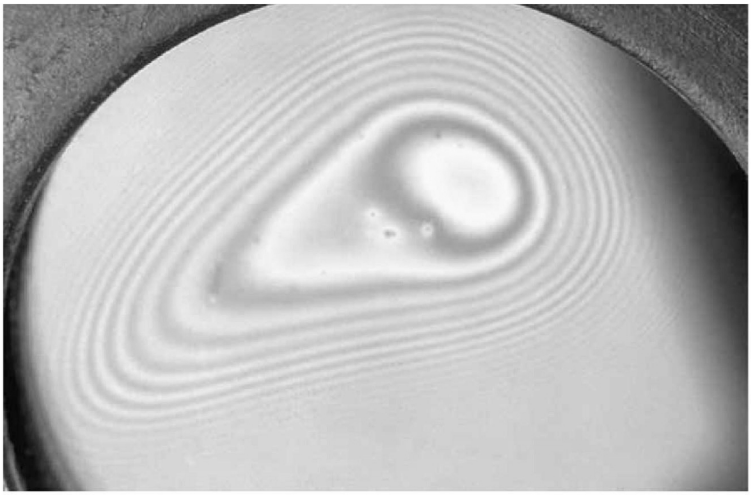

Newton's Rings

It turns out a single photon can interfere with itself! How can this be? It must somehow split up and consider both the available paths reflecting off the glass surfaces.

Now that we have these two concepts in our head, that a photon sometimes reflects and sometimes does not, and a single photon must consider both paths, we can ask: what tells the photon what to do?

There are only three possible answers: the light source that emitted the photon, the pane of glass that reflected the photon or the observer that saw the photon – me.

The first obvious place that might control the photon is the original source of the photon; the light bulb. The photon might leave the bulb already knowing what path to follow, whether it will be reflected and whether that reflection will be affected by the gap between the two surfaces in a positive or negative way. This is sometimes called a pilot wave theory. The problem with this theory is I could insert a piece of glass into the experiment after the photon has left the light source. This will affect the photon but the light source could not have known my intention in advance and told the photon what to do. Therefore, the path of the photon is not pre-programmed by the light source.

Now our photon has left the bulb and is traveling toward the glass. The glass has two surfaces. The photon reaches the first surface and has to decide if it will reflect. But there is a problem. The second surface

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will have an effect on this decision – constructively or destructively. The photon can't make up its mind at the first surface. It has not yet seen the second surface.

The photon travels on and reaches the second surface. It needs to make a decision: Shall I reflect or not? It cannot decide that it should have been reflected from the first surface because it is already at the second surface; it's too late.

The photon is stuck. It cannot make the decision at the first surface because that is too early, nor at the second surface because that is too late. The glass surfaces cannot be the source of the decision.

This leaves only one remaining option: I, the observer, *tell* the photon what to do. The word 'tell' is probably a little strong. Sadly, I am not that powerful. All I can do is tell the photon to make up its mind. When the photon reaches my eye, it *must* decide what happened to it along the journey, but this decision appears purely random and I have no effect upon it. The best way physicists have found to describe what is going on is to say particles, such as a photons, behave according to a wave function. Particles oscillate between all the possible options available to them and when we take a measurement this freezes the oscillations and gives a single result.

Where exactly is the measurement made? At my eye when the photon is refracted by the lens, when the photon enters the aqueous humor, or perhaps as it interacts with the rods and cones in the retina. Maybe we must wait until the detection of the photon is converted into an electrical impulse in the optic nerve or even the point at which my human consciousness perceives it.

This prompted the physicist John Bell to ask a slightly tongue-in-cheek question, "Was the world wave function waiting to jump for thousands of millions of years until single-celled creatures appeared? Or, did it have to wait a little longer for some more highly qualified measurer – with a Ph.D.?" You see his point. Where is the bar set that defines a measurement?

One of the most extreme answers to Bell's question is the strong anthropic principle. It argues humans – or at least sentient beings, perhaps even cats – *cause* the Universe to exist. The Universe bubbles along in a state of superposition with every possible event occurring and bifurcating until an observer emerges in one of the branches and the whole edifice collapses to that state. It is not clear if this produces many concurrent universes or if the first universe with a sentient being wins!

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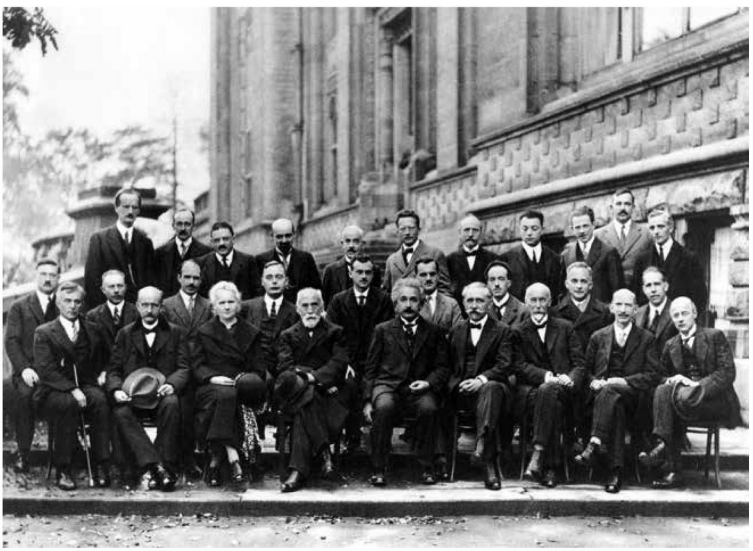

Solvay Conference

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"There is no way to understand the mechanism that turns the water of the brain to the wine of consciousness."

Colin McGinn

"If you think this Universe is bad, you should see some of the others."

Philip K. Dick

Schrödinger's Cat

Measurement is a big puzzle. What causes the collapse of the wave function so that the photon stops considering many optional paths and makes a hard and fast decision. When light passes through a series of glass surfaces, it is reflected or transmitted by each. We can stack up as many pieces of glass as we want, but none of the surfaces will cause a measurement – a collapse of the wave function. It is not until the photon reaches a detector that a measurement is made and all the potential reflections and transmissions that might have happened 'collapse' into the one choice that actually happened.

You might doubt this but there are ingenious experiments that can be performed to prove it. One is quite simple to do and can be set up on your kitchen table with a handheld laser and $100 worth of optical components. You need three ordinary mirrors and a beam splitter. Beam splitters are often made from half-silvered mirrors. They are similar to your bedroom mirror except the silver coating is more thinly applied, allowing only half the light to reflect while the rest passes straight through. Arrange the mirrors and beam splitter on a table at the four corners of an imaginary box, as in the diagram. If you point your laser at the half-silvered mirror, half the light will go straight through and half will be reflected upwards towards the first mirror. It is sent on around the square until it meets the half-silvered mirror again, and the beams meet up. You might expect that half the light reaches the detector but this is not what happens. Depending on the way the mirrors are positioned, either all the light reaches the detector, or none does. (The light does not disappear it just gets sent back to the light source, energy is conserved.) If you turn down the brightness of your laser, this does not change. Even

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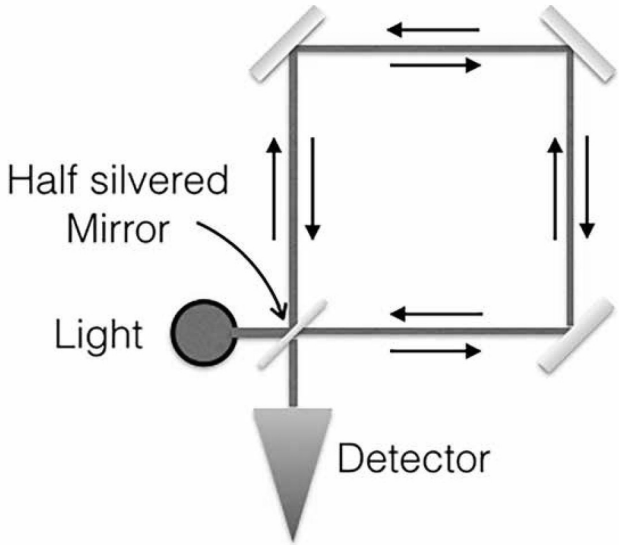

Interferometer

if only one photon is traveling at a time, still no light comes out in one direction and all the photons come out the other. The wave functions of each photon interfere with each other constructively or destructively. The only conclusion available is the photon must be traveling along both paths! They are said to be in 'superposition'. If you introduce a measuring device half way around the experiment, it will destroy the superposition and the photons behave in the common sense way. Remove the measuring device and, once again, the photons seem to take both paths. Richard Feynman pointed out that you really have to imagine that the photons take every possible path, not only the straight line paths. He received his Nobel Prize for demonstrating how to add up these infinite paths to get a finite answer with his 'sum over histories method'. Superposition is a strange idea when limited to the realm of small particles but what about larger things? – cats for example.

Erwin Schrödinger's unfortunate cat is trotted out to demonstrate the paradox so often that Stephen Hawking is on record for wanting to reach for a gun every time he hears mention of it.

The thought experiment works like this. A cat is put in a box with a radioactive substance, a Geiger counter and a vial of poison. If the counter detects a radioactive decay it breaks the bottle and the cat dies, if no decay is detected the cat lives.

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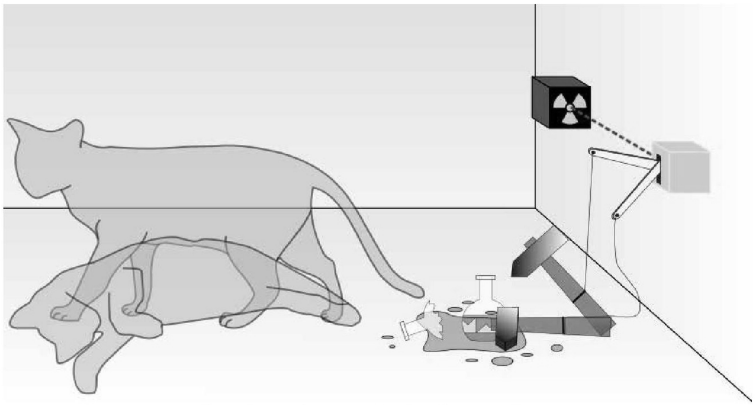

Schrödinger's Cat – both Alive and Dead

Since radioactive decay is a quantum event, we have to assume it might or might not have happened right up until the point of measurement. It is the same with any quantum event: photons reflecting from a piece of glass, measuring the spin of an electron or measuring the polarization of a photon. All these quantum effects exist in superposition until measured. But in the real world, we don't experience superposition. If I miss the train, I miss it. I don't partially catch it and partially miss it, and I don't experience any such quantum ambiguity. The only place I ever see such effects is watching science fiction movies. In real life the large scale world is certain. At what point does this quantum uncertainty transition to our classical certainty? What is the state of the cat before I – a sentient observer – open the box? Was the result of the decay measured by the Geiger counter, the cat, or are we waiting for someone to open the box and observe the result?

The Copenhagen interpretation of quantum mechanics – named after the main center of early quantum theory at the Niels Bohr Institute – says the cat is both alive and dead until I make a measurement. The cat is said to be in superposition, meaning a live cat and a dead cat inhabit the same volume of space-time 'experiencing' both alternatives and waiting for my measurement. This seems nonsensical, but Copenhagen quantum folk simply say, "That's the way it is; the mathematics works, if you don't like it, tough. Nature does not have to explain herself."

Einstein strongly disagreed with this position. He believed the world is certain and laws must govern radioactive decay and, therefore, the breaking of the vial and the life and death of the cat. There must be some, as yet, undiscovered theory. He reasoned as follows: A particle

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has position, velocity and spin. Why can it not have more hidden information that tells it when to decay? Perhaps particles are composed of sub-particles that cause the weird quantum effects we see.

We *have* discovered sub-particles – quarks and the like – but more than a hundred years of experimentation have gradually ruled out any form of theory explaining how these random events can be governed by the properties of the particle. The collapse of the wave function just seems to happen randomly.

There is one explanation for quantum mechanics that avoids the measurement problem altogether but it is even stranger than the Copenhagen interpretation: 'the many worlds' view'. The idea was first put forward by Hugh Everett in 1957, and it claims measurements are never made, there is never a collapse of the wave function, and every wave continues to exist. We just can't see them all. There is a version of me that has seen a live cat and another in a parallel universe that saw a dead one. The two versions of me are also in superposition, just like the cat, so there are an infinity of parallel universes tracking every possible option.

The only measurable consequence of this 'many worlds' idea is the existence of enormously enjoyable science fiction plots and much poking of fun between the many worlds camp, and the no-many-worlds camp. The single-worlds proponents point out the whole idea is untestable and just plain odd. For example, each choice we make, every reflection and any quantum process generates a new branch in the Universe. This is a vast amount of information to track and puts us back in a position where moral choices have no consequence. Every decision I make spawns a Universe where I made a different choice.

For a humorous take on this, you can visit a website and buy your own Universe for $2.99. You pose a question based on the throw of a die, let's say, one to three I go to work today and, four to six, I take a sick day. The website generates a quantum random number using an experimental setup at a laboratory in California. You can make your choice based on this quantum random number in the certain knowledge that another Universe springs into existence where you made the alternate choice, so somewhere you are not taking a sick day after all, and can be found hard at work at your desk.

There is one more explanation for quantum measurement, proposed by Roger Penrose. He proposes gravity comes to the rescue. Once enough particles are involved in the superposition of states, the curvature in space time becomes great enough to force a measurement event. In his view, a measuring instrument is simply an amplifier which brings a

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quantum event to the point where gravity begins to matter. His solution removes the requirement for many worlds and, indeed, our curious position as the conscious beings that bring the world into existence. Of course, Penrose does not stop there. He proposes the quantum gravity interaction gives rise to conscious thought and this process is the root of mathematical intuition.

The aim of our discussion is to show where determinism might break down in the physical laws of the Universe. If our Universe is determined, there will need to be a huge quantity of information stored somewhere to tell it what to do at each step. Storing a script for the Universe is not the conventional way people imagine determinism works. Rather they explain the apparent complexity we see through the application of a simple set of rules called 'the laws of physics'. We imagine using these laws to expand up a small set of starting conditions into the complexity of the Universe we experience. This is similar to the way fractals produce beautifully complex images from a tiny quantity of information. For example, the Mandelbrot set is created from a single, simple mathematical statement just twelve characters long, with one or two starting numbers. If this is how our Universe works then our thoughts and actions are just like the fronds of a fractal. It would mean the particles in the Universe 'know' what they will do next and carry enough information with them to determine their next action. This is a testable hypothesis and the test we have devised to measure this is the twin particle experiment.

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Right and Left Socks

"Was the world wave-function waiting to jump for thousands of millions of years until single-celled creatures appeared? Or did it have to wait a little longer for some more highly qualified measurer - with a Ph.D.?"

John Bell

Twins

There are several ways to make twin particles. The 'easy' way is with a laser and a nonlinear crystal. A beam of ultraviolet photons enters the crystal and about one in a billion times they interact with quantum fluctuations in the crystal lattice to create two red photons. This is known as 'spontaneous down conversion'.

There are two types of down conversion. In a type I interaction the twins have the same polarization, and in a type II they are at 90 degrees to each other. You can set up the experiment with either type, but it is important to remember which you used, or you will easily become confused. When we *talk* about photon experiments, we are usually referring to type I interactions because they are easier to understand. Often the actual experiment uses oppositely polarized photons because they are easier to generate.

Polarization is a wavelike property of photons. You can visualize them wiggling up and down, side-to-side or something in between. We use polarization to our advantage when we go on holiday to the beach; light from the sun is randomly polarized, but when it glances off the ocean it becomes predominantly horizontally polarized. If we wear vertically polarized sunglasses the glare off the ocean is blocked and we can see the ocean more clearly. The following two pictures show this effect.

The two photons we make with the crystal can be separated and sent to different places. The record so far is two towns near Geneva, 50 kilometers apart. For this experiment scientists 'borrowed' the unused fibers of Swisscom in the middle of the night – when phone traffic was light. A detector was placed at the end of each fiber to measure the particles.

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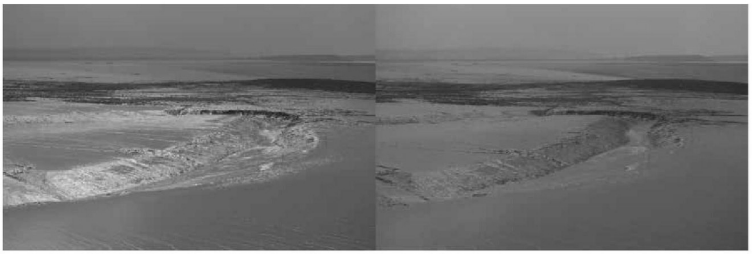

Effect of Polaroid Lenses

When scientists examine the polarization of these photons, they get random results. Sometimes the photon is oscillating side to side, sometimes up and down and sometimes part way in between. This can be determined simply by taking a lens out of a pair of Polaroid glasses, holding it up at an angle and seeing if the photon can pass through. Obviously laboratory grade Polaroid material is available, so scientists don't have to destroy an expensive pair of designer glasses, but the principle is identical.

Very strange things happen when the measurements are made. The polarizations appear to have no discernible pattern, but once one of the photons has gone through a polarizer in the first town, its sister photon will always be found to have the opposite polarization (or the same if it was a type I)..

Einstein was uncomfortable with this for two reasons. The first related to his famous statement, "God does not play dice with the Universe." He was deeply uncomfortable with the idea that the polarizations were random. Even more troubling to him was the idea that the sister photon somehow instantaneously had the opposite polarization. How would it know? For the sister photon to immediately have the opposite polarization, information would have to travel faster than the speed of light from the first photon to tell its sister what to do. In 1935, Einstein wrote a paper with Jacob Podolsky and Samuel Rosen describing this 'EPR' paradox. Since faster than light communication was impossible – it breaks the law of special relativity – they concluded quantum mechanics must be wrong, or at least incomplete. A deeper theory would be needed to explain the particles' behavior. One very simple explanation is by analogy to socks! (Clothing analogies are one of the ways physicists try to make quantum mechanics less intimidating.)

Consider sister photons as if they were right and left socks. If we found a left sock on the bedroom floor, we would be unsurprised to find the matching sock was a right one. There is no need for messages to flow

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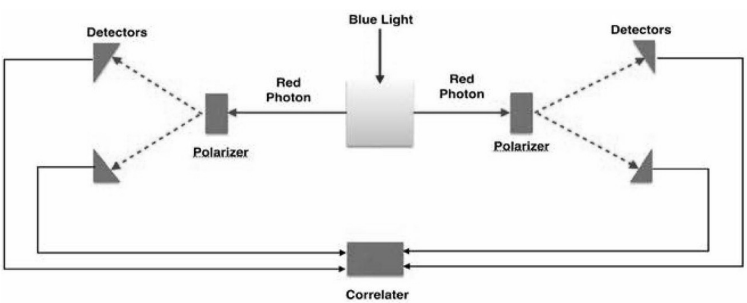
between the socks faster than the speed of light to synchronize them, they already know what they are! Einstein presumed sister photons were like socks; they were emitted from the light source with their polarizations already set, though you could not see this information until you measured one of the photons. The information was dubbed 'hidden' and the theory is called hidden variable theory.

Einstein was to be proven wrong.

For many years after the EPR paper was published, physicists split into factions: some thought the world random, some believed in hidden variables, and others thought attempts to 'understand' quantum mechanics were misguided. Why should physics make sense? The equations work. Who cares why?

In 1964, John Bell, an Irish physicist working at the Conseil Européen pour la Recherche Nucléaire ('CERN'), devised a way to test Einstein's hidden variable theory. He pointed out that if photons possess hidden variables and we randomly measure them with a detector set at three angles, we would expect to see more than one-third of the photons share the same result. But, in 1972, Freedman and Clauser performed this experiment and showed the photons share the result only a little over a quarter of the time. Since 'a little over a quarter' is less than 'more than a third', Bell's theory is false. Of course, Bell was entirely happy about this, since he set the equation up to be disproven. His equation is called an inequality because the equation contains a more than sign '>' rather than an equals '=' sign, so people say that quantum mechanics violates the Bell inequality. Because the inequality is violated, photons can have no prior knowledge of their polarization.



Bell Test Experiment

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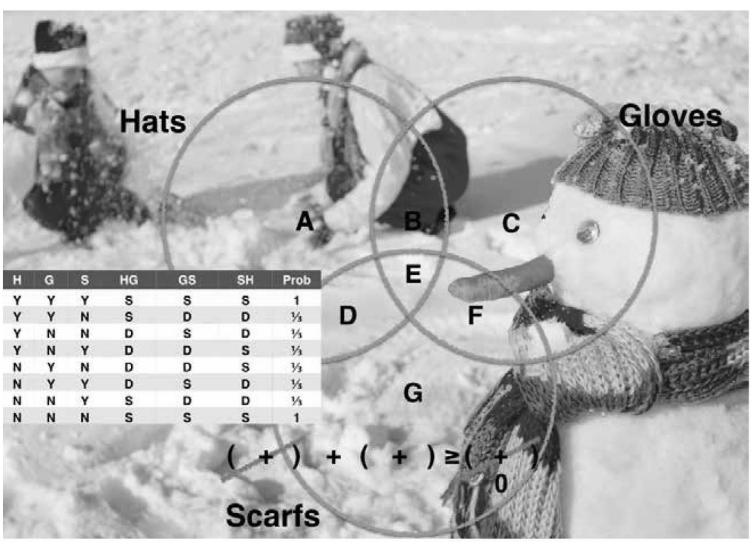
This is quite a complex piece of mathematics so let me show you how it works. Again, our thought experiment relies on an analogy involving clothing – sorry.

In the Bell Test experiment three polarizers are set up at 0, ⅓ and ⅔ of the way around a circle, 120 degrees apart. For Einstein to be correct photons must each carry at least three pieces of information:

If I meet the 0 degree polarizer do I go through or not?
If I meet the 120 degree polarizer do I go through or not?
If I meet the 240 degree polarizer do I go through or not?

If a photon had only one piece of information, say that it was vertically polarized, it would not *know* what to do if it came across a polarizer at 45 degrees. In that case the photon would sometimes go through and sometimes not, with a fifty-fifty probability. But Einstein did not want to countenance probability. "God does not play dice with the Universe." He required certainty. "I like to think the Moon is there when I am not watching it." The photons must know enough to handle, with certainty, any eventuality they may come across. (We could set up experiments with a more complex set of choices, dividing the photons into quarters, fifths and so on, but thirds are simple numbers and we can use the children's clothing analogy to demonstrate the mathematics.)



H	G	S	HG	GS	SH	Prob
Y	Y	Y	S	S	S	1
Y	Y	N	S	D	D	⅓
Y	N	N	D	S	D	⅓
Y	N	Y	D	D	S	⅓
N	Y	N	D	D	S	⅓
N	Y	Y	D	S	D	⅓
N	N	Y	S	D	D	⅓
N	N	N	S	S	S	1

Hats, Scarves, and Gloves

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We could liken photons knowing three pieces of information to children in a playground choosing to wear either hats, scarfs or gloves in some combination: hats for vertical, gloves for 120 degrees and scarfs for 240 degrees. There are eight choices for each child; nothing, hat, gloves, scarf, hat and scarf, hat and gloves, scarf and gloves, or all three.

Bell asked how often we would see two measurements agree. Look at the illustration and you can see when this happens. If a child was wearing all the clothes then if you check any pair, say gloves and scarfs you will always get a yes. If one of the children is wearing none of their winter clothes, you will always get a no for any pair you check. In these two cases, we are always sure to get agreement. For all the other cases, only one in three of the tests will agree. So Bell said that any time you have something with three hidden variables, there is at least a one in three chance that the measurements you make will agree, since six of the tests are one in three and the other two are certain.

Due to Heisenberg's Uncertainty Principle we can only look at one piece of clothing at a time. But, there is a trick. If there are identical twins among the children – who always dress the same way in our analogy – we can look at the gloves of one twin and the hat of another. Because they are twins if the first twin is wearing a hat we know the second one is too, without looking. We have a trick to measure two things at once.

When the test is done on twin photons only one in four, one quarter, agree. So there is a problem with the children analogy. It turns out photons don't wear gloves, hats, and scarfs. There are no hidden variables. A photon does not know what it will do before you measure it and can only decide on the fly at the point of measurement.

This means quantum particles are not *there* when they are not being observed. Observing them *does* appear to make them real. If the hidden variables, the gloves, hats and scarfs were in set positions when we were not observing them, the photon measurements would agree at least one-third of the time, but they do not. When we measure them, the two particles somehow communicate and agree to give a positive result only one quarter of the time. Bizarre, but that's just the way it is!

The Bell result is still somewhat controversial and has not been proven to everyone's satisfaction. Potential loopholes exist but are steadily being eroded. An experiment by Nicolas Giseng of CERN using the fiber optic network of Swiss Telecom to separate twin photons, shows the coordination signals must travel at least 10,000 times the speed of light – the limitation, and reason it is not infinitely fast, being the accuracy of his clocks. Daniel Sego, Daniel Danziger and Michael Wise have performed the Bell test experiment with an apparatus installed near Innsbruck

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where the choice of detector orientation was made by a random number generator after the photons had left the emitter. This shows the photons really can't know what they will do before they start their journey. Another loophole is the loss of some photons. We don't measure *all* the photons in an optical experiment because some are absorbed by the apparatus. It has been suggested all the 'lost' photons make up the error in the experiment. This is not very likely, it's akin to assuming all the voters who did not vote in an election would have voted Democrat. To avoid this criticism, an experiment has been performed with magnetized particles that don't get lost. The Bell result holds true.The loopholes are diminishing and it seems likely Bell will win out in the end.

Although the coordination information appears instantaneous, John Bell gave us an elegant explanation as to why this does not allow us to use the effect to transfer information faster than the speed of light. Imagine we are sitting at opposite ends of a room. We both toss coins and each of us write down our results; heads, tails, heads, heads and so on. I then acquire a magical power that causes your coin to make an extra flip just before you catch it, so it always gives the opposite result to mine. Although I am now controlling your coin, you cannot tell, as the result looks as random as before. The difference is simply that at first the coin orientation was random in its own right and then the opposite of my random result. It is only when I walk over and compare our results we can see they are matched in this strange way. There is no way to transmit information using this effect. Only after the experiment is finished can we exchange the necessary information to see the coordination that existed, and that comparison required me to transfer information. The fastest way to do that is at the speed of light.

Despite saying it is impossible, let us do a thought experiment and try to transmit information using Morse code. I will set up a simple old fashion telegraph machine. When I press the telegraph button at my end this will cause a measurement and the photons at your end will be forced to the opposite polarization. When I lift the key, your photons will revert to being randomized. You can see this illustrated in the diagram. Although I make your photon take up a polarization, analogous to making the coin take an extra flip, you don't have enough information to know this.

Now we are ready to use our quantum Morse machine to prove the Universe must have free will, or at least a degree of non-determinism.

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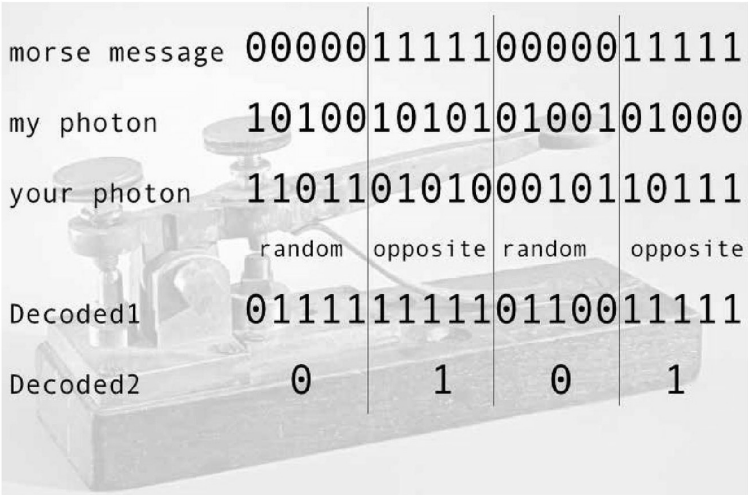

Quantum Morse Machine

A Simple Free Will Theorem

In the quantum Morse machine, I *do* transmit information faster than the speed of light. But the information I have transmitted is useless as it is, in effect, encrypted using a one-time pad. The only person in possession of a copy of this one-time pad is me: the sender.

Claude Shannon proved a one-time pad is unbreakable during the Second World War. Yet the British succeeded in breaking it. How was this possible?

The fatal weakness in the German one-time pads was the random numbers used to code the messages were generated by a machine, and were therefore not truly random. The numbers followed a sequence, and it was possible for Allied code breakers to work out the sequence and decode the messages. It follows that if we believe no message can propagate faster than the speed of light, my sequence of numbers must be non-computable. There must be no algorithm or computation that could generate it. Otherwise it would be liable to the same sort of decryption attack that the one-time pads suffered. If sequences of random measurements taken in the universe are non-computable it follows the Universe as a whole must be non-computable.

There are a few holes you could pick in this argument. Would it be sufficient if it were impossible to decrypt the message in the age of the Universe? What if there was an algorithm, but it was practically unknowable? But, I am talking here of principle. In principle, the Universe must be non-decryptable.

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Richard Dawkins and the Atheist Tour Bus

"God exists, if only in the form of a meme with high survival value, or infective power, in the environment provided by human culture."

Richard Dawkins

Does God have Free Will?

Any discussion of free will is incomplete without some mention of God. Scientists generally avoid the topic, but since we're talking about such a fundamental concept, we must consider whether the Universe would be any different if it had a creator.

Recently there have been two widely publicized attacks on religious belief from the scientific community: the head-on attack from Richard Dawkins in *The God Delusion* or, the hard hitting sideswipe by Stephen Hawking in *The Universe in a Nutshell*.

Hawking made the front pages in 2000 with the statement: "There is then no need for a creator." He was considering whether God needed to ignite the Big Bang or if it occurred as a natural result of the laws of physics. Hawking had run the mathematics and realized a god was not needed to light the blue touch paper for the Big Bang - the laws of physics spontaneously caused it. His argument does not actually preclude the existence of a god, but it does move the point where we need a creator one step further up the chain.

This is not a fundamental change to the progress of theological argument over the last thousand years. Once we abandon our vision of God as a master builder, literally breathing life into Adam while putting the finishing touches to the Garden of Eden, we can move him up the causal chain as far as we like, eventually reaching a point where intervention is necessary to get things started. Hawking is only pointing out an intervention is not needed at the point of the Big Bang. It still begs

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the question "Where did the laws of physics come from?" If you don't believe in a god then pushing a creator figure further and further up the chain eventually makes him redundant. If you have faith, you can take the position God is the creator of the fundamental rules.

Regardless of your personal position, I would like to make the argument for free will independent of belief. We must resolve the age-old paradox: How can God be all-knowing and all-powerful, and still have free will?

This is a long-standing theological debate dating back to the 15th century. It splits theologians into two camps. The first maintains God has both omniscience and omnipotence, and they are not inconsistent. This is the compatibilism argument again. Despite the acknowledged paradox, they argue that we should simply accept it and acknowledge that we are unable to comprehend such things. I don't like this argument because it essentially denies reason. We are supposed to acknowledge that we simply cannot understand the mind of God. I prefer the more modern argument from the second camp that omnipotence trumps omniscience. It preserves the view that man can reason about the Universe – "Man is made in God's image."

This argument follows the logic: God must be able to choose not to know what will happen in the future so that he can have free will.

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Fork in the Road

"When making a decision of minor importance, I have always found it advantageous to consider all the pros and cons. In vital matters, however, such as the choice of a mate or a profession, the decision should come from the unconscious, from somewhere within ourselves. In the important decisions of personal life, we should be governed, I think, by the deep inner needs of our nature."

Alan Turing

The Free Will Theorem

In 2006, John Conway and Simon Kochen published *The Free Will Theorem*. The paper received huge press attention and has been widely discussed in the scientific community. Their theorem states that; provided experimenters are free to run their experiment as they choose, the behavior of the particles they experiment upon is not determined in advance. Particles have free will!

If we go back to the Bell Test experiment, this proved twin particles do not carry around a parcel of information telling them what to do. Perhaps they get their marching orders from some outside influence. There are two possibilities. A particle is either told what to do by its environment or it gets its information from some data source. Can we use the laws of physics to test these possibilities? We don't need to know how the influence works, just that it might exist in principle.

Conway and Kochen prove there can be no external influence, and when a particle reveals its spin, that spin was not known beforehand. It is independent of any information in the history of the Universe up to that point.

Conway and Kochen's proof is elegant and involves some mental gymnastics, but it is no harder than Archimedes' proof of the infinity of primes we looked at earlier. Let us start with our twin particles. We are going to pick bosons, which have whole number spin. If you measure the spin, you will always get a reading of -1, 0 or +1. 'Spin' is one of those words physicists use to explain quantum things. It does not necessarily denote rotation but, if your mental model is a spinning top, that's not too

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bad. If we measure something in the quantum world, it always yields a classical result – in this case the magnitudes of spin are 1, 0 and 1. (Minus one squared is one.)

We need to imagine measuring the spin of a particle along three axes; x, y and z. Hold your hand up and make a shape that looks like the one in the following picture. You might remember it from science classes; it was used to help you understand Fleming's left-hand rule. For our purposes it does not matter which hand you use; it is just the shape that matters. I am going to use my left hand for sentimental reasons.

Now, imagine the palm of your hand is the measuring apparatus: your index finger the x axis, your middle finger, y and your thumb, z. At any moment you can move your hand to point in any direction and take a measurement. We will have to round up or down. Quantum mechanics is named 'quantum' because *all* the readings must be whole numbers. You will never see 10% spin in x, 90% in y and 85% in z; just ones, and zeros. The measurements for a Boson will always be 1,0,1 in some order. This is known as the '101' rule.

Now, we ask the question: does a particle have a definite spin before we take a measurement? The instinctive answer is yes, and this way of viewing things is known as realism. It seems obvious that even if we did not make a measurement, the particle would still have its spin; we just wouldn't know which type. Einstein explained realism by saying "I like

Kochen Specker

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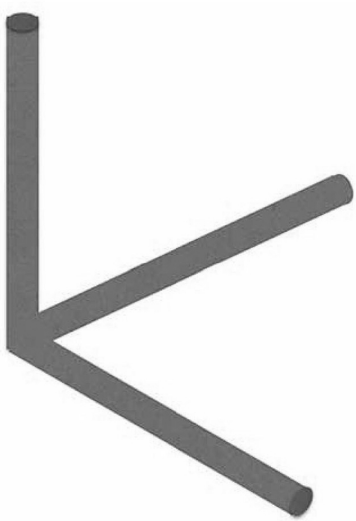
to think the Moon is there when I am not looking at it." But, how can we test his statement? How can we know something is there without taking a look? There is a way...

Let us suppose the particle had a definite spin before we measured it. Perhaps its spin points at the top left hand corner of the room. Imagine taking many measurements and seeing what happens. We can point our hand in any direction: top of the room, bottom left corner, bottom right corner and so on. Each time we point our hand in a direction we must get 1, 0 and 1 in some combination (110, 011, 101). The particles are 101 particles and this is an absolute rule.

Let's imagine doing the experiment. We fix the spin of a particle and begin to take measurements, noting the answers as we go. If we get a borderline condition we obey the 101 rule and give ourselves a 1, 0, 1 reading. As we move our hand to take measurements, a problem begins to emerge. Every now and again we obtain a measurement that conflicts. We chose a 1, 0, 1 when we were pointing our index finger towards the floor, but if we point the finger toward the door, we need that original middle number to have been a 1 for consistency. (The middle finger is now pointing in the direction the index finger pointed to for the first reading.) To fix the inconsistency we can change our original borderline decision to a 1,1,0. All is well and we continue. But, as we get over 30 measurements, we can't seem to find any way to make all the 1,0,1s fit together. After scratching our head for a while, we realize there might be no solution. And indeed there is not. This is the Kochen-Specker Paradox. The odd shaped cubes on the building in the Escher print are an example of one of these impossible figures.



1 0 1 puzzle piece

An analogy to this problem is trying to solve a broken Rubik's Cube. There is a really mischievous trick you can play on someone: reverse two colors on a Rubik's Cube. You can easily do this by snapping one of the edge blocks out, turning it around and snapping it back in. When the colors are already muddled up this is not obvious. Now give your

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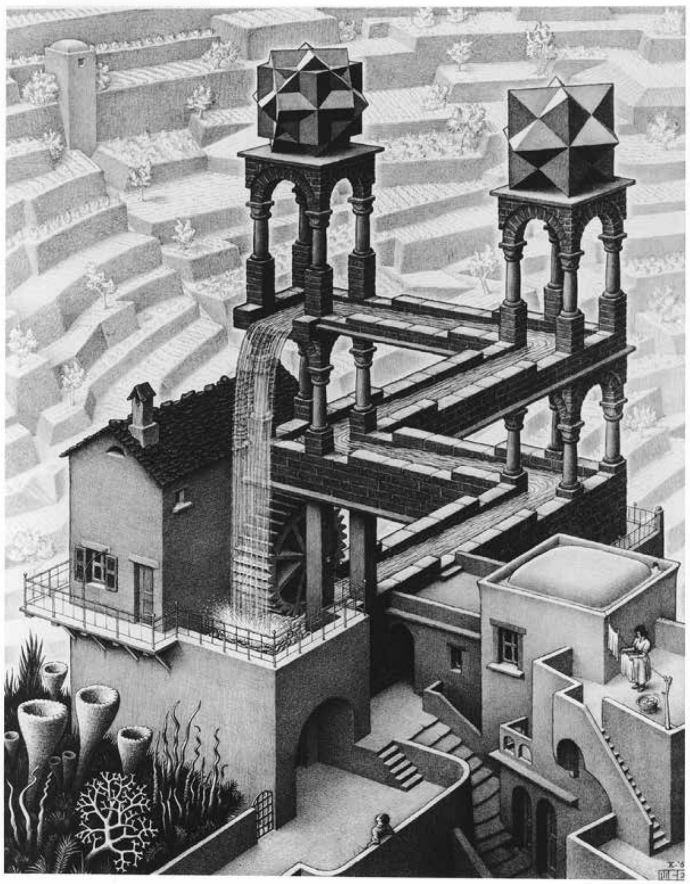

M. C. Escher's Waterfall (Impossible Shapes)

friend the puzzle and they will spend hours trying to solve it! It can't be done because the puzzle is put together wrong. And in this matter nature is also put together wrong! With as few as 33 measurements it is impossible to construct a consistent three-dimensional shape that has 1s and 0s obeying the 101 rule in every place. The only way to complete such a shape is with a measurement that is both simultaneously zero and one: a paradox. We know what happens when we generate paradoxes. It means one of the original assumptions is false and, in this instance, the falsehood is that a particle has a definite spin before we measure it. It

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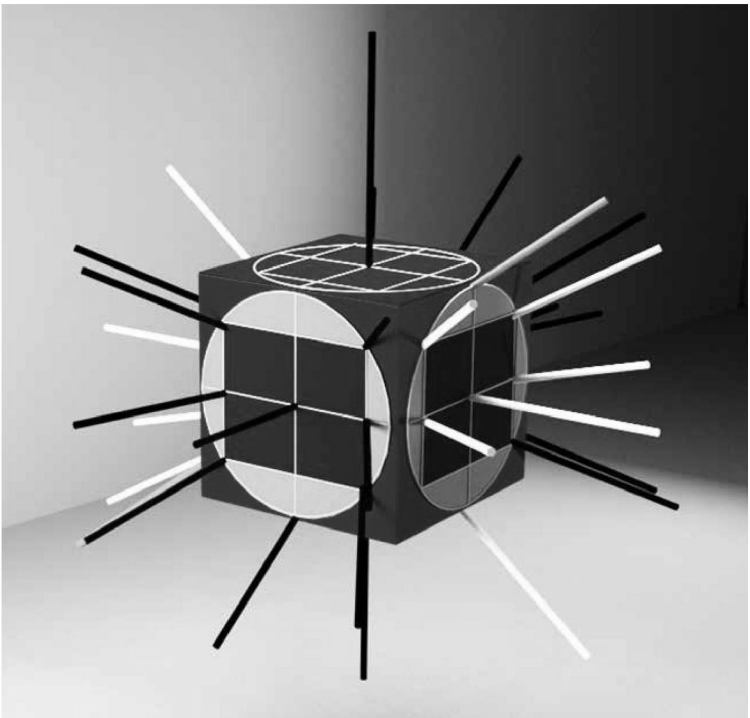

Kochen-Specker Cube

cannot. It must make up its mind on the fly. Einstein would be horrified. Realism is violated by the quantum world: reality and measurement are intertwined.

The Kochen-Specker paradox shows us that a particle only makes its choice at the point of measurement. This does not prove it has free will as it might still be told what to do by some external entity. It's rather like the famous game show, *Who Wants to be a Millionaire?* The particle could answer the spin question in four possible ways. First, it could *know* the answer, but we have just proven it does not. Second, it could *phone a friend* obtaining the answer from some cosmic arbiter. Third, it could ask the audience and take a vote from all the particles around it. Finally, it could freely choose, without recourse to any of the other possible options – in other words, it would guess!

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A guess would mean particles have free will; no extraneous influence or piece of information either on their person or from some external source could have any effect. We are now going to prove the particle *does* guess.

The Proof

Conway and Kochen construct their proof from a small set of axioms, which form a rhyme. The axioms are; twin, fin and spin.

If two particles are separated by a distance (fin) and entangled (twin), the spins of the particles (spin) cannot be determined by any information in *their* history of the Universe up to that point. The proof relies on a thought experiment.

Consider twin particles separated by a long distance. Physicists call this 'space like separation'. All this means is one particle is measured on, say, Earth and the other on Mars, so relativity is significant in the experiment. This may be impractical today but there is no reason the experiment could not be done in principle. In the future, our children could set up on the UN Moon base and fire one photon to a detector on Hubble II and the other to the future Mars Orbital Station. Farfetched? If you had told Einstein back in 1947 that in less than 70 years we would be able to measure individual photons by sending them down spun glass fibers to locations separated by 50 kilometers, involving a multidisciplinary team composed of American, German, French and Russian scientists, all working in harmony, he might have been equally incredulous.

As the proof introduces relativity we also need two imaginary rocket ships. They must be traveling below the speed of light, so no Star Trek Enterprise or Millennium Falcon. We will have to stick with an old-school spaceship, the Sulaco from *Aliens* should do the trick. They must travel in opposite directions, passing our Moon Base just as the scientists run the experiment.

Special Relativity shows our Universe has a strange property: there is no such thing as a simultaneous event for two observers – at least if they are separated by any distance. From the point of view of the first spaceship, the measurement on Mars occurs first. But from the vantage point of the second observer, the measurement on Hubble occurs first.

Now comes the proof by counter example. Let us suppose the particles *were* influenced by an outside effect and had no free will.

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Let us say the Mars particle chooses its answer because of an external influence. Its Hubble twin must choose the same answer. There is no problem with this because the Hubble particle could have made its decision before the Mars particle, so the decision was not predetermined.

But in another frame of reference the choice is made in the opposite sequence. The Hubble particle chooses after the Mars particle. This is predetermination and it breaks the Kochen-Specker theorem.

You can reverse the whole analysis and see the same problem from the other point of view. There is a paradox here however you look at it.

The only solution to the paradox is that both particles make their choice without any information from an outside source; particles have free will. This means at least one new piece of information spontaneously appears in the Universe – a 'bit' of free will, so to speak.

You might think there is a problem because the first particle affects its twin, even if the second did not receive any outside influence. This would result in the Kochen-Specker paradox reemerging. There is a neat way out of this; time has no meaning for the particles. Or, I should say, relative time has no meaning and, therefore, has no effect. There is no concept of before or after between the particles. They live in a little bubble of space-time where the order of events has no meaning. The particles make their free choice together within this safe bubble, and the paradox is avoided. When we come to measure them, we see they both made a random decision together, but if we ask which made it first, the question has no meaning. There is no clock valid for both particles, so there is no possible answer to the question.

Conway and Kochen have proven sub-atomic particles have free will – or at least entangled bosons do. At this point, their argument becomes a philosophical one. They propose that these particles pass on this free will to larger entities in the Universe and ultimately to us. Although particles are small and insignificant, they are the fundamental building blocks of nature, and the butterfly effect multiplies up tiny variations in the microscopic world into the macroscopic events we see.

Although their theorem is very elegant, we still have to address the question of whether the experimenter has the true freedom to run the experiment in the first place: the determined determinist argument.

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Russian Dolls

"Great fleas have little fleas upon their backs to bite 'em.

And little fleas have lesser fleas, and so ad infinitum.

And the great fleas themselves, in turn, have greater fleas to go on.

While these again have greater still, and greater still, and so on."

Augustus De Morgan

Free Will Universe

I believe we live in a Universe where information comes into existence through the creative endeavors of human beings. When Andrew Wiles discovered his solution to Fermat's Last Theorem, he did something a computer cannot do and demonstrated non-computational thought. But there is an alternative explanation put forward by the determined determinists.

Daniel Dennett – the standard bearer for this camp – believes everything in the Universe is entirely determined. He argues there is no place in the laws of nature for free will to arise.

Both sides of the argument agree Turing prohibits a general-purpose machine from solving all mathematical problems, but that seems to be the extent of agreement. The determinists solve the Wiles Paradox by arguing he is a special purpose machine, perfectly able to find answers to non-computable problems. The Turing prohibition only applies to general purpose machines. Let us run a thought experiment to see what sort of Universe we would live in if special purpose machines were the answer to this puzzle.

If the Universe is determined, it can be modeled as a single algorithm. If everything in the Universe evolves according to a set of rules, it will run like a giant piece of clockwork or one large computer game. Each solar system, planet, and individual mathematician would evolve along preordained lines. Mathematicians would operate as software subroutine and would rely on further subroutines to explain the beating of their hearts and the way the molecules of their body interact.

If our Universe were organized in this way:

This Universe *could not* discover solutions to arbitrary problems.

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This Universe *could* be preprogrammed with every theory we could ever discover within it. (There would be no arbitrary problems.)

This argument neatly sidesteps Turing's theorem by specifying there is no such thing as an arbitrary problem – a random problem picked from the infinite set of problems. At the same time, it sets certain characteristics of such a Universe and I believe we can test these...

A computable Universe must already know the solution to every problem it will encounter above the logic limit: It cannot discover knowledge on the fly. For many problems, a small number of fundamental rules can account for everything. Although our galaxy and the beautiful nebulae we see through our telescopes look complex, they might be the result of some such simple set of rules – just like a fractal. That's Stephen Wolfram's solution to the mystery of our Universe. But some problems are complex. The solution to Fermat's Last Theorem is an 80 page document consisting of 5 million bits of information. All this must be stored somewhere in the Universe. It might not be stored as a string of bytes, it could be found in a set of equations governing the motion of the atoms such that at some point – in 1995 to be exact – they all line up in Andrew Wiles' brain to direct his fingers to type out the proof. In this case, the Universe has solved a mathematical puzzle because it was specifically set up to do so from the time of the Big Bang, but this raises three questions:

Where does the Universe store this enormous amount of information?

How does The Universe hold the information reliably?

How did the pre-Universe solve the problem, so it might program the Universe at the moment of the Big Bang?

The first question is probably answerable. The Universe is a big place and could store sufficient information to solve the mysteries that puzzle the inquisitive creatures that inhabit its planes. There are many practical problems to consider, such as how to preserve the information through all the strange evolutions of our Universe; inflation, star formation, and so on. But it could be done.

The second question is insurmountable and presents the counter argument to the determinists. Our Universe appears to be composed of non-deterministic objects. Such objects exist in the mathematical world; Kochen-Specker cubes, for example. Unfortunately for the determined determinist, bosons behave according to the same principles. In case you're thinking thinking bosons are rare, light is formed of bosons. Our

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whole existence is surrounded by non-deterministic physics. Therefore, your actions are not predetermined by anything in your local corner of the Universe – the past light cone if you want to be strict about the physics.

The determined determinists are a determined bunch. Just because the information that determines your actions cannot be encoded by the particles you are made from, does not mean you are free. The information could be stored in parts of the Universe we cannot see, or held outside the Universe in some sort of cosmic hard drive. Every creative event in the Universe would be specified in this store.

But this begs the third question: How was this store of information generated in the first place? If a Universe contains creative things – as our Universe does – there is no way to computably generate the necessary determinist store of information. The Universe has free will because there is no deterministic process that could generate it.

If our Universe were a Turing machine, everything within it would be too. Think about the deterministic clockwork argument I gave earlier. If you try to construct a better – say a more random – machine inside a Turing machine, an observer could simply ignore the better machine hidden within it, and watch the outer machine work. The outer machine will predict the operation of the inner machine perfectly, even if the inner machine is fiendishly complicated. We have to consider the machine on which our human software runs. Our bodies, our minds, all that we are, is software running on the Universe's hardware of quarks and photons. If the hardware is deterministic, then so is our software. And if the hardware is deterministic, there can be no creativity within the Universe.

So the free will camp has an argument easily as frustrating as the one deployed by the determinists. Every time a determinist asks, "How do you know you were not always going to do that?" the free will believer can reply, "You asked me a question. If this dialogue is to have any significance, then we must exist in a rational Universe and, therefore, the laws of information give us creativity and free will. If you believe we are fully determined, there is no point in my answering your question."

I reason. Therefore, I have free will.

The Universe is not a machine.

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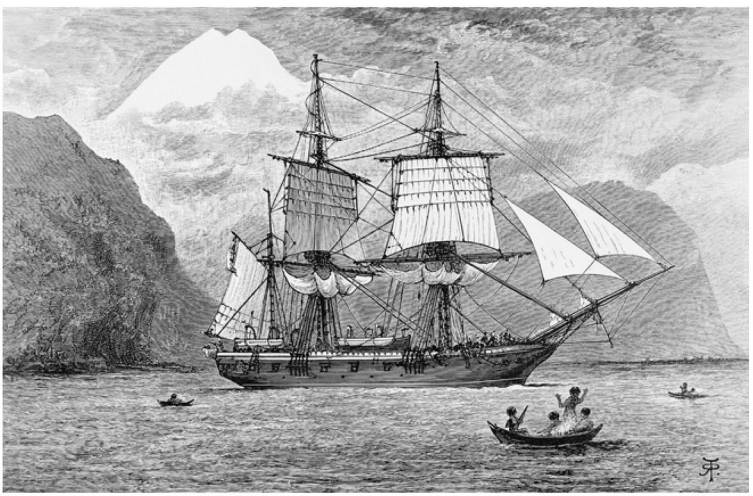
Chapter 16

THE QUEST FOR KNOWLEDGE



Darwin's Beagle

"Sometimes I've believed as many as six impossible things before breakfast."

Queen of Hearts in
Lewis Carroll's Alice

"It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change."

Charles Darwin

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We celebrate creativity with many competitions and prizes. I have been a student of problem lists of over the years. Here is my list of the problems remaining open in the modern world. I've tied it in with other lists where relevant, and indicate what you might win if you were to solve one. As I was writing this book, a few of the questions were answered; the Higgs Boson was discovered and the Poincaré Conjecture proven. I will keep the list up to date on the web site.

1. **Mathematics** Fields Medal
   - 1.1 The Birch and Swinnerton-Dyer Conjecture.[C]
   - 1.2 Hodge Conjecture [C]
   - 1.3 Navier-Stokes Equations [C]
   - 1.4 A proof or disproof of P =NP [C]
   - 1.5 The Poincaré Conjecture [C] – Solved
   - 1.6 Riemann Hypothesis [h8 C]
   - 1.7 Yang-Mills Theory [C]
   - 1.8 Can we understand and solve all 23 Hilbert Problems [h1-23]
   - 1.9 Goldbach Conjecture [h8]
   - 1.10 Is mathematics fundamental to or simply a good model of our Universe? [H6]
   - 1.11 Is mathematics an emergent property in our Universe or causal? Which is more fundamental?
   - 1.12 Fermat's own original proof of his theorem!

2. **Physics** Nobel Prize for Physics
   - 2.1 Are there many worlds or just one?
   - 2.2 Does quantum collapse have meaning?
   - 2.3 Will we find the Higgs-Boson? (Provisionally yes, 2012)
   - 2.4 Do we need quantum gravity to explain human thought?
   - 2.5 Will we observe gravitational waves, and what is the current explanation for gravitational noise?
   - 2.6 What causes the arrow of time and the asymmetry of physical laws?
   - 2.7 Do the constants of physics change over time?
   - 2.8 Is quantum computation sufficient to simulate the universe, or is the universe non-computational?
   - 2.9 Can magnetic monopoles exist?
   - 2.10 What is meant by quantum non-locality, a.k.a., spooky action at a distance?

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2.11 Is there a theory that would unite gravity with the other three forces: a Theory of Everything?
2.12 Is Schrödinger's cat alive or dead in the box?
2.13 Does ball lightning exist and can it be made in the laboratory?

3. Cosmology Nobel Prize for Physics

3.1 What is the nature of Dark Matter?
3.2 What is the nature of Dark Energy?
3.3 What is Dark Flow?
3.4 The slingshot anomaly.
3.5 Did inflation really happen?
3.6 Was there a singularity at the origin of our Universe, and what happened before the first second? An eternity?
3.7 Can any information travel faster than the speed of light?
3.8 What is the cause of the Pioneer anomaly? (solved in 2011)
3.9 Are there aliens?
3.10 The Goldilocks question. Why are the cosmological constants so finely tuned?
3.11 Do real numbers exist or is our Universe quantized?
3.12 Why is there little antimatter?
3.13 What are cosmic rays and where do they come from?
3.14 What was the WOW signal?
3.15 Does the fine structure constant vary over time?
3.16 If we live in an infinite Universe, why don't we see more strange things?
3.17 Why is the cosmic background radiation so smooth?
3.18 How can we explain the lack of total smoothness of the cosmic background radiation!
3.19 Is there an explanation for any detail in the cosmic background radiation map?

4. Engineering Nobel Prize for Chemistry, Turing Award

4.1 Can we achieve economic nuclear fusion?
4.2 Will we realize cold fusion? (Partially demonstrated)
4.3 Can an amateur get to the moon?
4.4 Can an amateur collect a rock from the moon? X
4.5 Will we make an Artificial Intelligence?
4.6 Can we make a Tricorder? X
4.7 Can we power the world from renewable sources?
4.8 Will robots go to war in the future?

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4.9 Can we make a robot indistinguishable from a human and cross the uncanny valley?
4.10 What is the tallest building we could build on planet Earth?
4.11 Will we routinely use flying cars by the end of this century?
4.12 Will we have a base on the Moon or Mars in this century?

5. Biology Nobel Prize for Medicine

5.1 Why is the placebo effect so strong?
5.2 Can we cure the common cold?
5.3 Is there a generally effective treatment for cancer?
5.4 Can we find a vaccine against HIV?
5.5 Can we cure endemic diseases such as malaria, or is it an arms race?
5.6 How plastic are our genes and is epigenetics a significant factor?
5.7 Can we cure dementia? [L]
5.8 Can we make a desktop gene sequencer? [X]
5.9 Will we prove the Kurzweil Hypothesis that technology will allow us to live forever?
5.10 How old will we live to with a reasonable quality of life?
5.11 Can genes jump between organisms? Even participating in whole scale fusion?
5.12 Will we be able to grow organs?
5.13 Will we clone a human from an adult?
5.14 Can we clone a dinosaur?

6. The Mind Nobel Prize for Medicine

6.1 Does the Flynn Effect mean we are really becoming more intelligent?
6.2 What is the nature of consciousness?
6.3 Do we have free will?
6.4 Which is more important: Nature or Nurture?
6.5 What is humor for?
6.6 Do some people have photographic memory? (yes, recent)
6.7 What is the purpose of sleep and, in particular, dreams?
6.8 What is understanding?
6.9 Do we ever truly know something?
6.10 How does the brain think?
6.11 Is the brain a quantum device?
6.12 Why do we get stressed?
6.13 Why are some people more intelligent than others?

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6.14 What limits our ability to concentrate and work hard mentally?

7. The Ancient World Pulitzer prize for History

7.1 What is the Linear-a script discovered in Crete?
7.2 Where are the ruins of the Light House at Alexandria and indeed Alexandria itself?
7.3 What is the location of the Lost City of Atlantis if it is not a myth?
7.4 Will we ever find King John's Treasure?
7.5 What is the truth to the legend of El Dorado?
7.6 Why were the pyramids built?
7.7 What was the purpose of Stonehenge and who built it?
7.8 How many books and how much knowledge have we lost?
7.9 Did King Arthur and Camelot exist in any real way?
7.10 Why did the people of Easter Island build their statues?
7.11 Was there an ancient flood, suggested by the Bible and other ancient texts?
7.12 Are the Seven Wonders of the Ancient World lost forever?

8. The Modern World Nobel Peace Prize or Prize for Economics

8.1 Is there a best political organization for a country?
8.2 What is the best political balance of federation and autonomy?
8.3 The Black Swan Effect: Why do improbable things happen?
8.4 Is there a right way to run the economies of the world?
8.5 When is it right to intervene in a conflict, and when is it best to leave a country to its own devices?
8.6 What is the best way to choose a political representative?
8.7 Will we ever abolish war?
8.8 Why is the gap between rich and poor increasing in most of the world today?
8.9 How powerful should states be compared with world organizations?
8.10 Is there a right level of tax?
8.11 Are morals absolute or relative: euthanasia, abortion, gay marriage, eating meat?
8.12 What will we do about our aging population?

9. Planet Earth Goldman Prize for the Environment

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9.1 Is man-made global warming real, and if already proven will we ever persuade the US government?
9.2 What caused the Tunguska Explosion?
9.3 What caused the extinction of the dinosaurs?
9.4 Can we predict earthquakes or eruptions?
9.5 What caused the reversing of the poles and when will the next one occur?
9.6 What was the origin of life on Earth?
9.7 Will we be wiped out by an asteroid before we build a suitable defense?
9.8 Can we grow enough food to feed the planet? [L]
9.9 Can we give clean water to everyone on the planet? [L]
9.10 Is increasing air travel compatible with survival of the planet? [L]

10. Philosophy Nobel Prize in Literature and others

10.1 Is there a God?
10.2 Where did we come from if we are not made by a god? And if we were, then where did God come from?
10.3 Where do morals come from?
10.4 Is there a reality?
10.5 Is there life after death?
10.6 Do we have free will?
10.7 Is beauty in the eye of the beholder?
10.8 What is the meaning of life, the Universe and everything, other than 42?

11. Conspiracy and Paranormal

11.1 Is there anything going on in the Bermuda Triangle?
11.2 Do aliens make crop circles? (disproven hoax)
11.3 Who was Jack the Ripper?
11.4 Can the mind bend spoons? (hoax, admitted)
11.5 Does the government suppress UFO existence?
11.6 Why was the Mary Celeste abandoned?
11.7 Is the Turin Shroud that of Christ?
11.8 Do the Abominable Snowman and Sasquatch exist?
11.9 Are there ghosts?
11.10 Is there a paranormal?
11.11 Do aliens live amongst us?
11.12 Was there a conspiracy in the shooting of JFK?

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Cross reference to other lists

Hn: Hilbert's Problem
C: Clay Mathematics Millennium Prizes
X: XPRIZE
L: Longitude Prize

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Nobel Prize Medal

"If I could explain it to the average person, I wouldn't have been worth the Nobel Prize."

Richard P. Feynman

Awards for Discovery

People like prizes. Competition drives humans forward in a way we don't properly understand. In film, we have the Academy Awards, whilst on the web we have The Webbies. Some prizes, such as the Nobel Prize, Fields Medal and Pulitzer Prizes, have a long and distinguished history, while others such as the XPRIZE are more recent creations. Some prizes, such as the Ig Nobel Prize and the Golden Pineapples were mainly created for their humorous value. Prizes are not a recent phenomenon. The Longitude Prize, originally won by John Harrison, is being revived in Britain in 2014 to mark its 300th anniversary. The original prize, £10,000 in its day, was awarded by the British government for making a device that allowed ships to determine their East-West position (a sextant only gives north-south). The 2014 prize is £10m pounds and the topic will be chosen by public vote! Here is a small history of some of the more famous prizes.

Nobel Prizes

Alfred Nobel spent his life developing weapons and explosives. His laboratory was built in the middle of a lake with a bridge running to it, so if he blew himself up doing an experiment, only he would die. He managed to stabilize nitroglycerine by mixing it with saltpeter and created

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Pulitzer Medal

dynamite. This was used in the mining industry but also extensively in weaponry, so he came to be known as the Merchant of Death during his lifetime.

To be known as the merchant of death would have a profound effect on anyone. As Nobel pondered the balance of his life's work he decided to do something positive with the huge wealth he had accumulated. On his death in 1896, he willed his entire fortune to create the awards we now call Nobel Prizes.

There were five original prizes; physics, chemistry, peace, physiology or medicine, and literature. A newer economic science prize is awarded by the Royal Swedish Academy of Sciences.

You must be alive to receive a Nobel Prize; a few have been awarded posthumously because the laureate died after the winner was announced but before the award ceremony. The work must have been proven experimentally, and although originally it was supposed to be for discoveries in the previous year, nowadays a theory must have stood the test of time. Consequently, winners tend to be quite old. The prize must be for something with practical applicability – Einstein received his Nobel Prize for the Photo Electric Effect, rather than his more famous Theory of Relativity. The judges evidently thought particles more practical than planets! The prize is usually awarded to a maximum of three people. This has produced some controversial results but despite this the Nobel Prize is the uncontested top prize in science.

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Pulitzer Prize

A Pulitzer Prizes is to the arts what a Nobel Prize is to science. Again the Prize was the result of a bequest. They are awarded in the fields of music, art and literature. Unlike Nobel Prizes, where there are no public nominations and you might wait a lifetime for the phone call, you enter your name for a Pulitzer Prize. Most people associate the term Pulitzer Prize winner with journalism, but about 25 Pulitzers are awarded each year. You must be a US citizen to enter.

Turing Award

Originally set up by the Association of Computer Machinery, this award comes with prize money of $250,000, supported by Google and Intel, and goes to a person who significantly advanced computer science or artificial intelligence in the previous year. It is considered the Nobel Prize for computing.

XPRIZE

XPRIZEs are awarded for technology and bear the democratic stamp of the Internet age. Anyone can propose a challenge but they must also provide the prize money! It's big money. The Ansari XPRIZE for the first

XPRIZE First Award Ceremony

non-governmental organization to put a man in space was $10 million, awarded in 2004. There are a growing number of XPRIZEs, including, at the time of writing:

- Google Lunar XPRIZE, $30m to put a rover on the Moon.
- Qualcomm Tricorder XPRIZE, $10m to make your mobile phone into a hand held medical health scanner, similar to the Star Trek tricorder.
- Nokia Sensing CHALLENGE, $2.25m to build a hand-held medical scanner.
- Wendy Schmidt Ocean Health XPRIZE, $2m to create a method to measure the ocean's pH.

Fields Medal

The equivalent of a Nobel Prize for mathematics is a Fields Medal. Joseph Field provided the money and helped set up the prize. Today it is administered as part of the International Mathematical Union. You must be under 40 to receive the prize. Andrew Wiles was 45 when he solved Fermat's Last Theorem, so they created a special prize for him called a Fields Fellowship. Until recently only men had received the prize. However in 2014 Maryam Mirzakhani won the prize for her work on the geometry of Riemann surfaces.

Fields Medal

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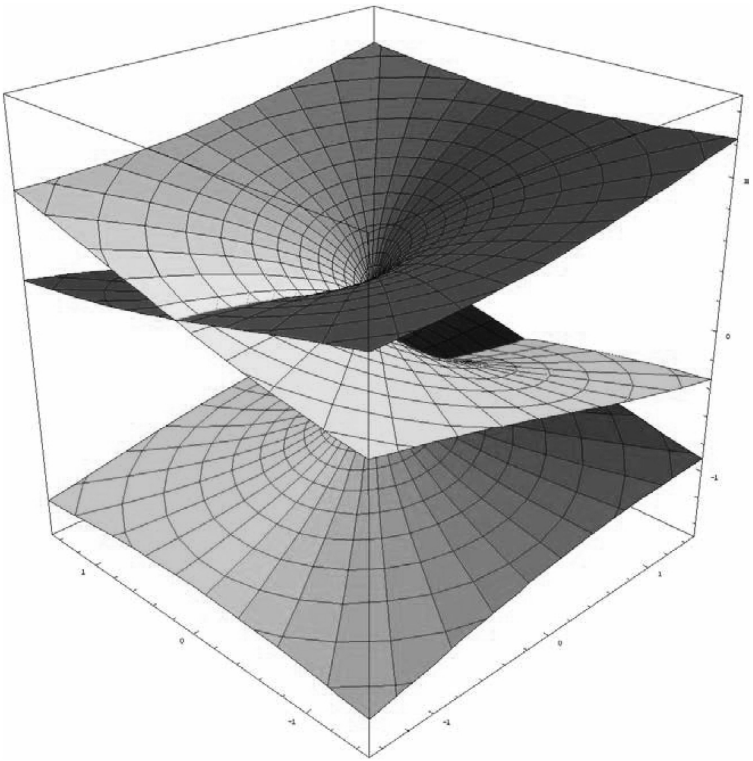

Riemann Surface

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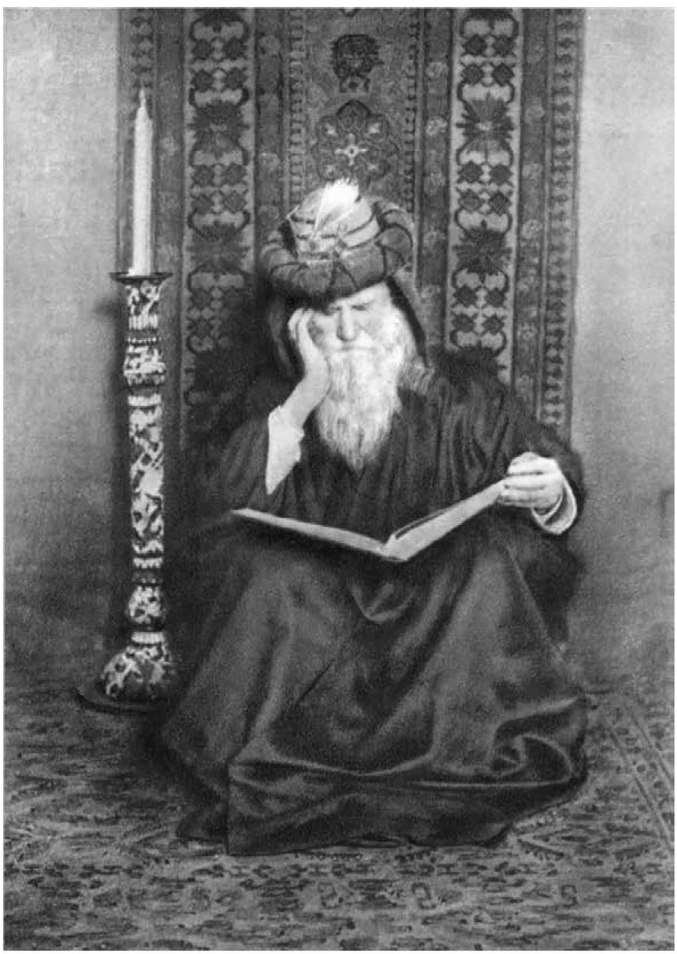
Chapter 17

THE FUTURE



Omar Khayyám

"Prediction is very hard, especially about the future."

Niels Bohr

"The Moving Finger writes: and, having writ, Moves on: nor all thy Piety nor Wit Shall lure it back to cancel half a Line, Nor all thy Tears wash out a Word of it."

Rubaiyat of Omar Khayyam,
Edward FitzGerald

رباعیات عمر خیام

I remember when I was eight years old, being asked to draw a vision of the world in the year 2000. In my the home of the future, rather than going to the shops to get milk, orange juice and cornflakes, they would arrive by pipe. These days I know about microbiology and realize this would have been highly impractical and perhaps rather dangerous. I could claim some premonition of the Internet at this point; no self-respecting science book is complete without one of these!

Of course, the truth is I had no more idea of the way things would turn out than anyone else. Now that I am a little older let's see how much trouble I can get into predicting the future.

I think we will build thinking machines – AIs – using our insights into the operation of the brain. They will not be like the computers of today but will still be physical devices. There is nothing overtly spiritual in my conception of the way we operate, but I am arguing that the human mechanism is more complex than a digital computer. Building these machines will be hard, and they will not be 'machines' in the sense I have used throughout this book. They will be minds.

When we build AIs that think and feel, will they acquire 'human' rights? Might one of my grandchildren fall in love with an AI, perhaps even marry one? On the darker side, how will they view us: what place would we have in their world once we had brought them into being? However, I think this process of building an AI will be hard and in one hundred years' time we will still be struggling with the problem.

In this book, I have presented a way to understand the creative process within our Universe. It relies on the existence of non-computable processes in our brain and in the physical laws which govern them. Currently, the laws contain a big hole. Although we can, perhaps, see where freedom might come from – through randomness and non-determinism – we don't understand where the will emanates to shape the Universe. Over the next thirty years, I think we will begin to understand this and see how creativity relates to the Universe we observe. I am not suggesting any anthropic principle, or some grand interaction between mankind and the Universe, just an important simple freedom: That we humans are free to think and do as we please. When I choose to lift my arm and raise a glass of wine with friends, this is my choice. I am the cause. The effect is the displacement of my arm, causing photons and gravitational waves to ripple out across the Universe, and in that sense I freely affect my environment.

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Da Vinci, Self Portrait

"A good painter is to paint two main things, men and the working of man's mind."

Leonardo da Vinci

Appendix 1

Acknowledgments

Front Matter

Cover	Vladislav Ociacia
Spine Equations	Illustration by Arabella Tagg
Author Photograph	Arabella Tagg
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Reading Room at the British Museum

"From the moment I picked your book up until I laid it down I was convulsed with laughter. Some day I intend reading it."

Groucho Marx

Appendix 2

Bibliography

I am not resident at an academic institution, nor do I work for a large company with access to a broad range of journal subscriptions. I have a degree in Physics and Computer Science, so I am no layman. The modern web gives amateurs like me, easy access to enormous information resources that would only have been available from the finest University libraries even five years ago. Over time I have built up a personal library of books in the field, many of them ex-library copies which, by their date stamps, were never borrowed in their home universities!

I'm always skeptical of the enormous bibliographies found in the back of science books and whether they are ever read. If you want a pointer to the next books to read, here are some suggestions: *A Brief History of Time, The Man who Mistook his Wife for a Hat, The Emperor's New Mind, The Naked Jape, Gödel Escher Bach, Proust and the Squid, Logic, A Five Day Course in Thinking, Your Brain on Music, The 4% Universe, From Eternity to Here* and *Time*.

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Journal	Cost
Scientific American	Some free articles, Membership $150 p.a.
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Science: The American Institute for the Advancement of Science.	Annual Subscription $151
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Chapter 1

Bellos, Alex. *Alex's Adventures in Numberland*. Bloomsbury Publishing PLC, 2010.

by Richard Roeper. *Urban Legends: The Truth behind All Those Deliciously Entertaining Myths That Are Absolutely, Positively, 100 Percent Not True*. Career Press, 1999.

Cairns-Smith, A. Graham. *Evolving the Mind: On the Nature of Matter and the Origin of Consciousness*. Cambridge University Press, 1996.

Dawkins, Richard. *The Magic of Reality: How We Know What's Really True*. Bantam Press, 2011.

Ericsson, K. Anders. "Attaining Excellence through Deliberate Practice: Insights from the Study of Expert Performance." *The Pursuit of Excellence through Education*, 2002, 21–55.

———. "Deliberate Practice and the Acquisition and Maintenance of Expert Performance in Medicine and Related Domains." *Academic Medicine* 79, no. 10 (2004): S70–81.

Ericsson, K. Anders, Ralf T. Krampe, and Clemens Tesch-Römer. "The Role of Deliberate Practice in the Acquisition of Expert Performance." *Psychological*

HOUSE_OVERSIGHT_016074

Review 100, no. 3 (1993): 363.
Fiske, John. *Introduction to Communication Studies*. 3rd ed. Routledge, 2010.
Franklin, Stan. *Artificial Minds*. MIT Press, 1997.
Gilovich, Thomas. *How We Know What Isn't So: Fallibility of Human Reason in Everyday Life*. Reprint. The Free Press, 1993.
Gregory, Robert J. *Psychological Testing: History, Principles, and Applications*. 6th ed. Pearson, 2010.
Hameroff, S. R. "Quantum Coherence in Microtubules: A Neural Basis for Emergent Consciousness?" *Journal of Consciousness Studies* 1, no. 1 (1994): 91–118.
Hameroff, Stuart R., and Alfred W. Kaszniak. *Toward a Science of Consciousness: The First Tucson Discussions and Debates*. MIT Press, 1996.
Harel, David. *Computers Ltd: What They REALLY Can't Do*. New Ed. OUP Oxford, 2003.
Hawkins, Jeff, and Sandra Blakeslee. *On Intelligence*. Reprint. Owl Books (NY), 2005.
Hofstadter, Douglas R. *Godel, Escher, Bach: An Eternal Golden Braid*. 20th Anniversary ed. Penguin, 2000.
Howell, E. *From Darness Light/Land of Stone/Shadow Worlds*. Centaur, 2010.
"IBM100 - Deep Blue." CTB14, March 7, 2012. http://www-03.ibm.com/ibm/history/ibm100/us/en/icons/deepblue/.
Ivancevic, Vladimir G., and Tijana T. Ivancevic. *Quantum Neural Computation*. Springer, 2010.
Jibu, Mari, and Kunio Yasue. *Quantum Brain Dynamics and Consciousness: An Introduction*. John Benjamins Publishing, 1995.
Jibu, M., S. Hagan, S. R. Hameroff, K. H. Pribram, and K. Yasue. "Quantum Optical Coherence in Cytoskeletal Microtubules: Implications for Brain Function." *Biosystems* 32, no. 3 (1994): 195–209.
Lahoz-Beltra, R., S. R. Hameroff, and J. E. Dayhoff. "Cytoskeletal Logic: A Model for Molecular Computation via Boolean Operations in Microtubules and Microtubule-Associated Proteins." *BioSystems* 29, no. 1 (1993): 1–23.
Malcolm Gladwell. *The Tipping Point: How Little Things Can Make a Big Difference*. Repr. Abacus, 2001.
Morris, Desmond. *Child: How Children Think, Learn and Grow in the Early Years*. Hamlyn, 2010.
———. *The Naked Ape: A Zoologist's Study of the Human Animal*. New edition. Vintage, 2005.
Neumann, John Von. *The Computer and the Brain*. 2nd Revised edition. Yale University Press, 2000.
Penrose, Roger. *The Large, the Small and the Human Mind*. New Ed. Cambridge University Press, 2000.
Přibram, Karl H., and Sir John Carew Eccles. *Rethinking Neural Networks: Quantum Fields and Biological Data*. Routledge, 1993.
"Return to Antikythera: Divers Revisit Wreck Where Ancient Computer Found." *The Guardian*, October 2, 2012. http://www.guardian.co.uk/science/blog/2012/oct/02/return-antikythera-wreck-ancient-computer.
Robinson, Ken, and Lou Aronica. *The Element: How Finding Your Passion Changes Everything*. Penguin, 2010.
Roebuck, Kevin. *Emotional Intelligence: High-Impact Strategies - What You Need to Know: Definitions, Adoptions, Impact, Benefits, Maturity, Vendors*. Tebbo,

2011.
Sacks, Oliver. *An Anthropologist on Mars*. 4th ed. Picador, 2009.
———. *The Man Who Mistook His Wife for a Hat*. 1st ed. Picador, 1986.
Tucker, William H. *The Cattell Controversy: Race, Science, and Ideology*. University of Illinois Press, 2009.
Turing, Alan M. "Intelligent Machines." *Ince, DC (Ed.)* 5 (1992). http://isites.harvard.edu/fs/docs/icb.topic958294.files/lecture-00-handout.pdf.
Vitiello, Giuseppe. *My Double Unveiled: The Dissipative Quantum Model of Brain*. John Benjamins Publishing, 2001.
Whitehead, Alfred North, and Bertrand Russell. *Principia Mathematica - Volume One: 1*. Rough Draft Printing, 2009.
Winston, Robert. *The Human Mind and How to Make the Most of It*. New edition. Chartered Institute of Personnel and Development, 2006.
Wolf, Maryanne. *Proust and the Squid: The Story and Science of the Reading Brain*. Icon Books Ltd, 2008.
Wolfram, Stephen. *A New Kind of Science*. First Edition. Wolfram Media Inc, 2002.

Chapter 2

Carr, Jimmy, and Lucy Greeves. *The Naked Jape: Uncovering the Hidden World of Jokes*. Penguin, 2007.
Cobley, Paul. *The Communication Theory Reader*. 1st ed. Routledge, 1996.
Dawkins, Richard. *Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*. Reisssue. Penguin, 2006.
Hume, David. *An Enquiry Concerning Human Understanding*. New Ed. /. OUP Oxford, 2008.
Locke, John. *An Essay Concerning Human Understanding*. Abridged edition. Hackett Publishing Co, Inc, 1996.
Martin, Robert M. *There Are Two Errors in the the Title of This Book**. Rev. and Expanded Ed. Broadview Press Ltd, 2002.
Sacks, Oliver. *An Anthropologist on Mars*. 4th ed. Picador, 2009.
Tufte, Edward R. *The Cognitive Style of PowerPoint: Pitching Out Corrupts Within*. 2nd ed. Graphics Press, 2006.
Wiseman, Prof. Richard. *Quirkology: The Curious Science Of Everyday Lives*. 2nd ed. Pan, 2011.

Chapter 3

Borg, James. *Body Language: 7 Easy Lessons to Master the Silent Language*. 1st ed. Prentice Hall Life, 2008.
Brounstein, Marty. *Communicating Effectively for Dummies*. John Wiley & Sons, 2001.
by Seth Godin ; with a foreword by Malcolm Gladwell. *Unleashing the Ideavirus : How to Turn Your Ideas into Marketing Epidemics*. Free Press, 2002.
Darwin, Charles. *The Origin of Species*. New edition. Wordsworth Editions Ltd, 1998.
Fiske, John. *Introduction to Communication Studies*. 3rd ed. Routledge, 2010.
Morris, Desmond. *Peoplewatching: The Desmond Morris Guide to Body Language*. Vintage, 2002.
———. *The Human Zoo*. New edition. Vintage, 1994.
———. *The Naked Ape: A Zoologist's Study of the Human Animal*. New edition. Vintage, 2005.

HOUSE_OVERSIGHT_016076

Navarro, Joe. *What Every Body Is Saying: An Ex-FBI Agent's Guide to Speed-Reading People*. HarperCollins Publishers, 2008.
Ogilvy, David. *Ogilvy on Advertising*. New edition. Prion Books Ltd, 2007.
Roebuck, Kevin. *Emotional Intelligence: High-Impact Strategies - What You Need to Know: Definitions, Adoptions, Impact, Benefits, Maturity, Vendors*. Tebbo, 2011.
Schirato, Tony, and Susan Yell. *Communication and Culture: An Introduction*. 2nd Revised edition. Sage Publications Ltd, 2000.
Taylor, Kathleen. *Brainwashing: The Science of Thought Control*. New Ed. OUP Oxford, 2006.
Winston, Professor Lord Robert. *Human Instinct*. New edition. Bantam, 2008.

Chapter 4

Derren Brown. *Tricks of the Mind*. Channel 4, 2006.
Gurney, Kevin. *An Introduction to Neural Networks*. CRC Press, 1997.
Hameroff, S. R. "Quantum Coherence in Microtubules: A Neural Basis for Emergent Consciousness?" *Journal of Consciousness Studies* 1, no. 1 (1994): 91–118.
Higbee, Kenneth L., and Ph.D. *Your Memory: How It Works and How to Improve It*. 2Rev Ed. Avalon Group, 2001.
Jibu, M., S. Hagan, S. R. Hameroff, K. H. Pribram, and K. Yasue. "Quantum Optical Coherence in Cytoskeletal Microtubules: Implications for Brain Function." *Biosystems* 32, no. 3 (1994): 195–209.
Jimmy Carr. *The Naked Jape : Uncovering the Hidden World of Jokes*. Michael Joseph, 2007.
Lahoz-Beltra, R., S. R. Hameroff, and J. E. Dayhoff. "Cytoskeletal Logic: A Model for Molecular Computation via Boolean Operations in Microtubules and Microtubule-Associated Proteins." *BioSystems* 29, no. 1 (1993): 1–23.
O'Brien, Dominic. *How to Develop a Brilliant Memory Week by Week: 52 Proven Ways to Enhance Your Memory Skills*. Duncan Baird Publishers, 2005.
Picton, P.D. *Neural Networks*. 2nd Revised edition. Palgrave Macmillan, 2000.
Siegelmann, Hava T. *Neural Networks and Analog Computation: Beyond the Turing Limit*. Birkhauser, 1998.
Winston, Robert. *The Human Mind and How to Make the Most of It*. New edition. Chartered Institute of Personnel and Development, 2006.
Wolf, Maryanne. *Proust and the Squid: The Story and Science of the Reading Brain*. Icon Books Ltd, 2008.

Chapter 5

Aaronson, Scott. *Quantum Computing since Democritus*. New York: Cambridge University Press, 2013.
Borges, Jorge Luis, and Andrew Hurley. *The Library of Babel*. Boston: David R. Godine Publisher Inc, 2000.
Chaitin, Gregory J. *Meta Maths: The Quest for Omega*. Atlantic Books, 2007.
Tolstoy, Leo. *War and Peace*. Ware: Wordsworth Editions, 2001.

Chapter 6

Ayer, A. J. *Language, Truth and Logic*. 2nd ed. Dover Publications Inc., 2002.
Boaler, Jo. *The Elephant in the Classroom: Helping Children Learn and Love Maths*. Souvenir Press Ltd, 2010.
Carroll, Lewis. *Lewis Carroll's Games and Puzzles*. 40th ed. Dover Publications Inc.,

HOUSE_OVERSIGHT_016077

1992.
———. *Symbolic Logic*. New issue of 1896 ed. Dover Publications Inc., 2000.
Crilly, Tony. *The Big Questions: Mathematics*. Quercus Publishing Plc, 2011.
Doxiadis, Apostolos, and Christos H. Papadimitriou. *Logicomix: An Epic Search for Truth*. First Edition. Bloomsbury Publishing PLC, 2009.
Goldrei, D.C. *Classic Set Theory: A Guided Introduction*. Chapman and Hall/CRC, 1996.
Hodges, Wilfrid. *Logic*. 2nd Revised edition. Penguin, 2001.
Martin, Robert M. *There Are Two Errors in the the Title of This Book**. Rev. and Expanded Ed. Broadview Press Ltd, 2002.
Newbery, John. *Logic Made Familiar and Easy: To Which Is Added a Compendious System of Metaphysics Or Ontology : Being the Fifth Volume of the Circle of the Sciences, &c. Published by the King's Authority*. BiblioBazaar, LLC, 2010.
Oechslin, Werner. *Byrne, Six Books of Euclid: Facsimile of the Famous First Edition of 1847*. Har/Pap. Taschen GmbH, 2010.
Russell, Bertrand. *Introduction to Mathematical Philosophy*. Reprint. Spokesman Books, 2007.

Chapter 7

Gleick, James. *Chaos: Making a New Science*. New edition. Vintage, 1997.
Griffeath, David, and Cristopher Moore. *New Constructions in Cellular Automata*. Oxford University Press, 2003.
"Mathematical Games - The Fantastic Combinations of John Conway's New Solitaire Game 'Life' - M. Gardner - 1970," June 3, 2009. http://web.archive.org/web/20090603015231/http://ddi.cs.uni-potsdam.de/HyFISCH/Produzieren/lis_projekt/proj_gamelife/ConwayScientificAmerican.htm.
Mitchell, Melanie. *Complexity: A Guided Tour*. OUP USA, 2009.
Weisstein, Eric W. "Elementary Cellular Automaton." Text. Accessed September 28, 2014. http://mathworld.wolfram.com/ElementaryCellularAutomaton.html.
Wolfram, Stephen. *A New Kind of Science*. First Edition. Wolfram Media Inc, 2002.

Chapter 8

Cantor, Georg. *Contributions to the Founding of the Theory of Transfinite Numbers*. Dover Publications Inc., 2003.
Clegg, Brian. *Brief History of Infinity: The Quest to Think the Unthinkable*. Robinson Publishing, 2003.
Cohen, Paul J. *Set Theory and the Continuum Hypothesis*. Dover Publications Inc., 2009.
Pica, Pierre, and Alain Lecomte. "Theoretical Implications of the Study of Numbers and Numerals in Mundurucu." *Philosophical Psychology* 21, no. 4 (August 1, 2008): 507–22. doi:10.1080/09515080802285461.
Pica, Pierre, Cathy Lemer, Véronique Izard, and Stanislas Dehaene. "Exact and Approximate Arithmetic in an Amazonian Indigene Group." *Science* 306, no. 5695 (October 15, 2004): 499–503. doi:10.1126/science.1102085.
Potter, Michael. *Set Theory and Its Philosophy: A Critical Introduction*. Clarendon Press, 2004.

Chapter 9

Chaitin, Gregory J. *Thinking About Gödel And Turing: Essays On Complexity 1970-2007*. World Scientific Publishing, 2007.

HOUSE_OVERSIGHT_016078

Franzén, Torkel. *Gödel's Theorem: An Incomplete Guide to Its Use and Abuse.* A K Peters/CRC Press, 2005.

Gödel, Kurt. *On Formally Undecidable Propositions of "Principia Mathematica" and Related Systems.* New edition. Dover Publications Inc., 2003.

Goldrei, D.C. *Classic Set Theory: A Guided Introduction.* Chapman and Hall/CRC, 1996.

Hofstadter, Douglas R. *Gödel, Escher, Bach: An Eternal Golden Braid.* 20th Anniversary ed. Penguin, 2000.

Nagel, Ernest, and James R. Newman. *Gödel's Proof.* Rev. Ed. New York University Press, 2001.

Newton, Sir Isaac. *Principia.* Prometheus Books, 1995.

Penrose, Sir Roger. *Shadows Of The Mind: A Search for the Missing Science of Consciousness.* New edition. Vintage, 2005.

Potter, Michael. *Set Theory and Its Philosophy: A Critical Introduction.* Clarendon Press, 2004.

Russell, Bertrand. *Introduction to Mathematical Philosophy.* Reprint. Spokesman Books, 2007.

Sautoy, Marcus Du. *The Music of the Primes: Why an Unsolved Problem in Mathematics Matters.* New Ed. Harper Perennial, 2004.

———. *The Number Mysteries: A Mathematical Odyssey Through Everyday Life.* Fourth Estate, 2010.

Whitehead, Alfred North, and Bertrand Russell. *Principia Mathematica - Volume One: 1.* Rough Draft Printing, 2009.

Chapter 10

Copeland, B. Jack. *The Essential Turing.* Clarendon Press, 2004.

David, Hans T. *The New Bach Reader: Life of Johann Sebastian Bach in Letters and Documents.* New edition. W. W. Norton & Co., 1999.

Dennett, Daniel C., and Douglas R. Hofstadter. *The Mind's I: Fantasies and Reflections on Self and Soul.* Basic Books, 2000.

Dewdney. *New Turing Omnibus.* Reprint. Palgrave Macmillan, 2003.

edited by B. Jack Copeland. *The Essential Turing : Seminal Writings in Computing, Logic, Philosophy, Artificial Intelligence, and Artificial Life plus the Secrets of Enigma.* Reprinted. Clarendon Press, 2005.

Gallwey, W Timothy, and Barry Green. *Inner Game of Music.* 7th ed. Pan, 2003.

Hofstadter, Douglas R. *I Am a Strange Loop.* Reprint. Basic Books, 2008.

Levitin, Daniel J. *This Is Your Brain on Music: Understanding a Human Obsession.* Atlantic Books, 2008.

Penrose, Roger. *The Large, the Small and the Human Mind.* New Ed. Cambridge University Press, 2000.

Penrose, Sir Roger. *The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics.* New Ed. Oxford Paperbacks, 1999.

Petzold, Charles. *The Annotated Turing: A Guided Tour Through Alan Turing's Historic Paper on Computability and the Turing Machine.* John Wiley & Sons, 2008.

Sacks, Oliver. *Musicophilia: Tales of Music and the Brain.* Reprint. Picador, 2008.

Singh, Simon. *The Code Book: The Secret History of Codes and Code-Breaking.* (Reissue). Fourth Estate, 2002.

Turing, Alan. "Checking a Large Routine." In *The Early British Computer Conferences*, 70–72. MIT Press, 1989. http://dl.acm.org/citation.

HOUSE_OVERSIGHT_016079

cfm?id=94952.
Turing, Alan M. "Can a Machine Think." *The World of Mathematics* 4 (1956): 2099–2123.
———. "Computability and Λ-Definability." *The Journal of Symbolic Logic* 2, no. 4 (1937): 153–63.
———. "Computing Machinery and Intelligence." *Mind*, 1950, 433–60.
———. "Computing Machinery and Intelligence." In *Computers & Thought*, 11–35. MIT Press, 1995. http://dl.acm.org/citation.cfm?id=216410.
———. "Intelligent Machines." *Ince, DC (Ed.)* 5 (1992). http://isites.harvard.edu/fs/docs/icb.topic958294.files/lecture-00-handout.pdf.
———. "Rounding-off Errors in Matrix Processes." *The Quarterly Journal of Mechanics and Applied Mathematics* 1, no. 1 (1948): 287–308.
Turing, Alan Mathison. "On Computable Numbers, with an Application to the Entscheidungsproblem." *J. of Math* 58 (1936): 345–63.
———. "Systems of Logic Based on Ordinals." *Proceedings of the London Mathematical Society* 2, no. 1 (1939): 161–228.
———. "The Chemical Basis of Morphogenesis." *Bulletin of Mathematical Biology* 52, no. 1 (1990): 153–97.

Chapter 11

Baxa, Christoph. "A Note on Diophantine Representations." *American Mathematical Monthly*, 1993, 138–43.
Blass, Andreas, and Yuri Gurevich. "Algorithms: A Quest for Absolute Definitions." *Bulletin of the EATCS* 81 (2003): 195–225.
Börger, Egon, Erich Grädel, and Yuri Gurevich. *The Classical Decision Problem*. Springer, 2001.
Carroll, Lewis. *Symbolic Logic*. New issue of 1896 ed. Dover Publications Inc., 2000.
Davis, Martin, Hilary Putnam, and Julia Robinson. "The Decision Problem for Exponential Diophantine Equations." *Annals of Mathematics*, 1961, 425–36.
Dyson, Verena H., James P. Jones, and John C. Shepherdson. "Some Diophantine Forms of Gödel's Theorem." *Archive for Mathematical Logic* 22, no. 1 (1980): 51–60.
Franzén, Torkel. *Godel's Theorem: An Incomplete Guide to Its Use and Abuse*. A K Peters/CRC Press, 2005.
Hodges, Wilfrid. *Logic*. 2nd Revised edition. Penguin, 2001.
Jr, Frederick P. Brooks. *The Mythical Man Month and Other Essays on Software Engineering*. 2nd ed. Addison Wesley, 1995.
Kurzweil, Ray. *How to Create a Mind: The Secret of Human Thought Revealed*. Penguin, 2012.
Matiyasevich, Yuri. *HILBERT'S TENTH PROBLEM: What Can We Do with Diophantine Equations?*. Accessed April 13, 2014. http://logic.pdmi.ras.ru/~yumat/Journal/H10history/H10histe.pdf.gz.
Minsky, Marvin Lee. *Computation*. Prentice-Hall Englewood Cliffs, 1967. http://cba.mit.edu/events/03.11.ASE/docs/Minsky.pdf.
Nagel, Ernest, and James R. Newman. *Godel's Proof*. Rev. Ed. New York University Press, 2001.
Penrose, Sir Roger. *Shadows Of The Mind: A Search for the Missing Science of Consciousness*. New edition. Vintage, 2005.
———. *The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics*. New Ed. Oxford Paperbacks, 1999.

HOUSE_OVERSIGHT_016080

Reid, Constance. *Julia: A Life in Mathematics*. Washington, DC: The Mathematical Association of America, 1997.

Rice, Henry Gordon. "Classes of Recursively Enumerable Sets and Their Decision Problems." *Transactions of the American Mathematical Society* 74, no. 2 (1953): 358–66.

Ruohonen, Keijo. "Hilbertin Kymmenes Probleema." *Arkhimedes*, no. 1 (1972): 2.

Spolsky, J. "The Law of Leaky Abstractions," November 11, 2002. http://www.joelonsoftware.com.

Tegmark, Max. "The Mathematical Universe." *Foundations of Physics* 38, no. 2 (2008): 101–50.

Turing, Alan M. "Can a Machine Think." *The World of Mathematics* 4 (1956): 2099–2123.

Turing, Alan Mathison. "On Computable Numbers, with an Application to the Entscheidungsproblem." *J. of Math* 58 (1936): 345–63.

———. "Systems of Logic Based on Ordinals." *Proceedings of the London Mathematical Society* 2, no. 1 (1939): 161–228.

Wiles, Andrew. "Modular Elliptic Curves and Fermat's Last Theorem." *Annals of Mathematics-Second Series* 141, no. 3 (1995): 443–552.

Chapter 12

Burgin, Mark. *Super-Recursive Algorithms*. Springer, 2005.

Darwin, Charles. *On the Origin of Species: By Means of Natural Selection*. Dover Giant Thrift Ed. Dover Publications Inc., 2006.

Mitchell, Melanie. *An Introduction to Genetic Algorithms*. New edition. MIT Press, 1998.

Siegelmann, Hava T. *Neural Networks and Analog Computation: Beyond the Turing Limit*. Birkhauser, 1998.

Syropoulos, Apostolos. *Hypercomputation: Computing Beyond the Church-Turing Barrier*. Softcover reprint of hardcover 1st ed. 2008. Springer, 2010.

Chapter 13

Shannon, C.E., and Warren Weaver. *The Mathematical Theory of Communication*. University of Illinois Press, 1949.

Chapter 14

Boden, Margaret A. *The Creative Mind: Myths and Mechanisms*. 2nd ed. Routledge, 2003.

Bono, Edward de. *How to Have Creative Ideas: 62 Exercises to Develop the Mind*. Vermilion, 2007.

———. *Lateral Thinking: A Textbook of Creativity*. Penguin, 2009.

———. *Six Thinking Hats*. Penguin, 2009.

Coyle, Daniel. *The Talent Code: Unlocking the Secret of Skill in Maths, Art, Music, Sport, and Just About Everything Else*, Random House Books, 2009.

Davis, Ronald D., and Eldon M. Braun. *The Gift of Dyslexia: Why Some of the Brighest People Can't Read and How They Can Learn*. 3rd Revised edition. Souvenir Press Ltd, 2010.

Edward De Bono. *How to Have Creative Ideas : 62 Exercises to Develop the Mind*. 1 Aufl. Vermilion, 2007.

Isaacson, Walter. *Steve Jobs: The Exclusive Biography*. Little, Brown, 2011.

McCandless, David. *Information Is Beautiful*. Collins, 2010.

HOUSE_OVERSIGHT_016081

Robinson, Ken. *Out of Our Minds: Learning to Be Creative*. 2nd Edition. Capstone, 2011.

Robinson, Ken, and Lou Aronica. *The Element: How Finding Your Passion Changes Everything*. Penguin, 2010.

Winston, Professor Lord Robert. *Bad Ideas?: An Arresting History of Our Inventions*. Bantam, 2011.

Chapter 15

Bell, John S., and others. "On the Einstein-Podolsky-Rosen Paradox." *Physics* 1, no. 3 (1964): 195–200.

Conway, John H., and Simon Kochen. "The Strong Free Will Theorem." *Notices of the AMS* 56, no. 2 (2009): 226–32.

Conway, John, and Simon Kochen. "Reply to Comments of Bassi, Ghirardi, and Tumulka on the Free Will Theorem." *Foundations of Physics* 37, no. 11 (2007): 1643–47.

Dennett, Daniel Clement. *Brainstorms: Philosophical Essays on Mind and Psychology*. 8. MIT Press, 1981.

Dennett, Danile C. *Kinds of Minds: Toward an Understanding of Consciousness*. Basic Books, 2008.

Ekert, Artur K. "Quantum Cryptography Based on Bell's Theorem." *Physical Review Letters* 67, no. 6 (1991): 661.

"EPR Paradox." *Wikipedia, the Free Encyclopedia*, September 15, 2014. http://en.wikipedia.org/w/index.php?title=EPR_paradox&oldid=625734938.

Gilovich, Thomas. *How We Know What Isn't So: Fallibility of Human Reason in Everyday Life*. Reprint. The Free Press, 1993.

Gisin, Nicolas. "The Free Will Theorem, Stochastic Quantum Dynamics and True Becoming in Relativistic Quantum Physics." *arXiv Preprint arXiv:1002.1392*, 2010. http://arxiv.org/abs/1002.1392.

Goldstein, Sheldon, Daniel V. Tausk, Roderich Tumulka, and Nino Zanghì. "What Does the Free Will Theorem Actually Prove." *Notices of the AMS* 57, no. 11 (2010): 1451–53.

Hawking, Stephen, and Leonard Mlodinow. *The Grand Design: New Answers to the Ultimate Questions of Life*. Bantam Press, 2010.

Heywood, Peter, and Michael LG Redhead. "Nonlocality and the Kochen-Specker Paradox." *Foundations of Physics* 13, no. 5 (1983): 481–99.

Huang, Yun-Feng, Chuan-Feng Li, Yong-Sheng Zhang, Jian-Wei Pan, and Guang-Can Guo. "Experimental Test of the Kochen-Specker Theorem with Single Photons." *Physical Review Letters* 90, no. 25 (2003): 250401.

Russell, Bertrand. *The Problems of Philosophy*. 2nd ed. Oxford Paperbacks, 2001.

Tumulka, Roderich. "Comment on 'the Free Will Theorem.'" *Foundations of Physics* 37, no. 2 (2007): 186–97.

Zhang, Yong-Sheng, Chuan-Feng Li, and Guang-Can Guo. "Quantum Key Distribution via Quantum Encryption." *Physical Review A* 64, no. 2 (2001): 024302.

Chapter 16

Land, George, and Beth Jarman. *Breakpoint and Beyond: Mastering the Future - Today*. Reprint. HarperBusiness, 1993.

Lloyd, John, and John Mitchinson. *QI: The Second Book of General Ignorance*. Faber and Faber, 2010.

HOUSE_OVERSIGHT_016082

Michael Brooks. *13 Things That Don't Make Sense : The Most Intriguing Scientific Mysteries of Our Time*. Profile, 2010.

Reason Special Interview with Roger Penrose, 2008. http://www.youtube.com/watch?v=xiYDc1LA0I4&feature=youtube_gdata_player.

Reason Special Interview with Roger Penrose, 2008. http://www.youtube.com/watch?v=xiYDc1LA0I4&feature=youtube_gdata_player.

Tegmark, Max. "The Importance of Quantum Decoherence in Brain Processes." *arXiv:quant-ph/9907009*, July 5, 1999. doi:10.1103/PhysRevE.61.4194.

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ATLAS, CERN

"Good one, publish."

Milliken

Appendix 3

Puzzles and Experiments

In this book I have suggested some experiments for you to undertake, and posed some puzzles to solve. You can participate in the experiments or see the answers by going online and checking my website at www.jamestagg.com

Jeopardy Answers from Chapter 1.

Answer 1. Watson answered, Gestate.

Answer 2. Watson answered. Who is Bram Stoker.

Answer 3. The answer is Chicago but Watson answered "Toronto?????", the question marks indicating it was very doubtful of the answer.

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Panda, Eats Shoots

"Parenthetical remarks (however relevant) are unnecessary."

Frank L. Visco,
How to Write Good

"Defining what we mean by a robot is hard to do. I know now when I see one but that definition works for anything, even pizza."

Mike Gregory

Appendix 4

Conventions in the Book

The use of *italics* is intended to give accent or indicate the title of the published work, such as a book or movie. Inverted Commas should read, 'so called'.

The use of the 'Oxford Comma' – a comma after 'and' – gives a longer break in a sentence to aid better understanding. You will find both 'and' and, 'and,' used in this book deliberately.

The use of 'their' substitutes for he or she, and is a convention I believe will supersede, 'he' or 'she' and, 'him' or 'her'.

The puzzles in this book are all available to download, so you don't need to deface the book. Feel free to deface it if you wish. Buy the electronic version and save trees.

Some of this book is historical or factual, while much is highly speculative. I have tried to indicate where ideas are controversial and where they are matters of accepted science. However, my experience is that much of what you are taught tends to be a gross generalization or even plain wrong. If you treat facts with a degree of skepticism, you will find this keeps you in good stead.

As someone who is highly dyslexic, there will be errors. Please email me the ones you find, and recommend the book to your friends so that I can afford to print a second edition with your corrections.

I have avoided the use of equations and mathematics, so you can see the flow of the philosophical argument. I also avoid a strongly historical narrative, but if you enjoy the history of science I recommend, *The Missing 4%*, and *Quantum* for a really clear exposé of the issues

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around quantum mechanics, relativity and cosmology, Robert Winston's *Bad Ideas* for a more thorough history of language and writing, and *The Trouble with Physics* for the recent history of particle Physics. Regarding the brain, anything by Oliver Sachs is a winner. *Your Brain on Music* is a good primer on the theory of artistic thought and music, and *Proust and the Squid* is a good discussion of dyslexia and learning.

The digits for the sequence of the Smallpox virus in Chapter Eight come from the varicella-zoster virus, a similar pathogen. The first few letters could be the same, but I hope it is impossible for anyone to disprove this as you would have to break into the CDC to do so.

John Masters is not the real name of the US officer who spoke in Kabul. That name was never released to the press.

This book was originally written using Microsoft Word on a MacBook Pro. It was then typeset for print using a variety of ePublication tools, including iBooksAuthor and Adobe InDesign. You can find a website for the book at www.jamestagg.com. It is published using WordPress. All the links in the book should be maintained there just in case there is link atrophy for the printed version of the book. Feel free to comment using the blog, Twitter, Facebook or email me.

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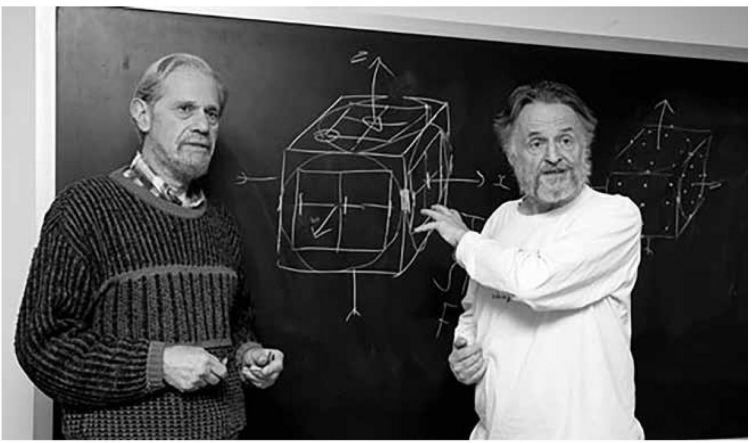

Conway and Kochen

"It doesn't matter how beautiful your theory is, it doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong."

Richard P. Feynman

Appendix 5

Index of Theorems

I have explained a number famous theorems in this book along with some ideas of my own. Here is a list of the most notable.

1. **Mind over Computer**
   Turing Test – How to tell whether a computer is intelligent, even though we cannot agree on a definition of intelligence.
   Flynn Effect – The observation that human intelligence appears to be improving over time.
   Kurzweil Singularity Proposal – The conjecture that Moore's Law will result in computers acquiring near infinite power relatively soon.
   Lucas Argument – Minds are in a different class to computers as they are not limited by the incompleteness theorem.
   Humor Hypothesis† – Humor and jokes are a display of non-computable intelligence.

2. **Understanding**
   Tufte's Assertion – That communication of understanding exceeds the capability of many presentation tools, particularly PowerPoint.
   Chinese Room – John Searle's paradox challenging the idea that understanding can be mechanically simulated.

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3. **Body Language & Banter**
   Communication Hypothesis† – That face to face communication is more powerful in some real physical sense than symbolic communication.
   7-38-55 Rule – Mehrabian's observation that the emotional content of communication is 7% words, 38% tone of voice and 55% body language.

4. **The Brain**
   Penrose-Hameroff Conjecture – Brains are quantum-gravity computers using tubulin as the mediator.

5. **Knowledge**
   Information Continuum Hypothesis† – Information is finite, but understanding and knowledge are different in nature.
   Infinite Monkeys Hypothesis – The paradox that says monkeys could type *Hamlet* given enough time and paper.
   Cat Experiment† – Finding my house cat can use our computer, and may be more creative than monkeys!

6. **Kittens & Gorillas**
   Feynman Proof – A proof that uses the lack of an evolved species within an evolutionary niche to disprove the existence of something; in this case polywater.
   The Infinity of Primes – Pythagoras' proof there are an infinity of prime numbers without needing the concept of a number.

7. **Complexity & Chaos**
   The Butterfly Effect – The proposal by Edward Lorenz that tiny effects can multiply up into enormous results.
   P≠NP – That non-deterministic polynomial problems can never be solved in polynomial time and are, therefore, beyond the capability of any imagined computer.
   The Hawking-Bekenstein Turk† – Although there is a perfect chess machine, it would collapse space-time to a black hole were it to exist.

8. **∞**
   Continuum Hypothesis – Does anything come between the first two infinities; counting numbers and the continuum of real numbers.

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Cantor's First Infinity Theorem – The infinite plane is the same infinity as the infinite line.

9. **Known Unknowns**
Gödel's Incompleteness Theorem – Mathematics involving simple logic is incomplete.
Gödel's Completeness Theorem – First order logic is complete.
Hilbert's Completeness Theorem – Geometry is complete.

10. **Turing's Machines**
Entscheidungsproblem – The decision problem has no solution.
Turing Thesis – All computers, once sufficiently powerful, are equally powerful.
Non-Computability of Music† – That general musical compositions are non-computable.
Non-Computability of Creativity† – That general artistic creativity is non-computable.

11. **Software**
Brooks' Law – Adding resource to a late project makes it later.
Law of Leaky Abstractions – However good the attempt to abstract complexity, complexity has a habit of leaking through.
Software is Created† – writing software is a non-computable, creative task.
Bug Hypothesis† – Bugs are an inevitable consequence of trying to generalize software by mechanical means.

12. **Hyper-Computing**
Adaptive Recurrent Neural Network Hypothesis – Hava Siegelmann's proposal that ARNNs are capable of super-Turing computation.

13. **Hyper-Communication**
Bandwidth Conjecture† – Person-to-person communication has infinite bandwidth and is non-symbolic.

14. **Creativity**
Creativity Hypothesis† – That all creative endeavor is a non-computable skill, analogue to theorem discovery.
Wallas Model – A conceptual model for the way humans think creatively.

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Creative Survival Advantage† – That creativity has evolved to give us a survival advantage at all stages of evolution, not just when we evolve to the point where mathematical intuition is significant.

15. **Free Will**

Laplace Daemon – A conceptual supreme being able to infer the future and the past from one snapshot of space-time and the laws of nature.

EPR Paradox – Twin particles would transmit information faster than the speed of light if quantum mechanics was to be believed.

Schrödinger's Cat – The paradox that a cat might be both alive and dead at the same time until observed.

Bell Inequality – Quantum mechanics forbids local hidden variables in a testable way. The test succeeds.

Kochen-Specker Paradox – Particles cannot know their settings before measurement.

Free Will Theorem – Nothing in the past light cone of the Universe causes a particle to choose its spin upon measurement.

Non-decryptable Universe† – The laws of physics mean the Universe is non-computable in principle.

Free Will Universe† – The laws of mathematics mean the Universe is non-computable and therefore has Free Will.

Russian Doll Conjecture† – Since humans are creative and non-deterministic and, in a sense, they run upon the hardware of the Universe, the hardware of our Universe must also be non-deterministic.

16. **The Quest for Knowledge**

Technology Hypothesis† – The extended strong anthropic principle that the Universe must have creative beings within it to uniquely define it.

17. **The Future**

Creative Non-Singularity† – The future is non-computable and therefore any increase in computer power, however great, will never achieve a creativity singularity.

† The symbol marks items proposed for the first time within this book. If I have missed a previous publication, please feel free to write to me and I will amend a future version.

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GEMs Paper #26

Saudi Arabia: beyond oil but not so fast

Merrill Lynch

30 June 2016 Corrected

Transforming Saudi Arabia, but challenges abound

The Saudi National Transformation Plan (NTP) bodes well for comprehensive reform efforts to diversify the economy in line with Vision 2030. The NTP a) identifies key sectors with high growth potential; b) starts to articulate supportive public sector industrial strategies; and c) seeks to foster higher value-added through enhancements to processes, products and organizations. Still, ambitious targets in a number of sectors are unlikely to be reached and medium-term macro sustainability is not yet clear.

USD peg holds but NTP inconsistent with stable FX policy

Our view is still that the USD peg holds. However, the NTP provides a mixed message. On the one hand, it blurs policymaking incentives given the need for a competitive Fx if diversification progresses. On the other, unrealistic fiscal targets mean consolidation is likely to fall short of easing imbalances materially without oil price recovery. Energy policy thus likely needs to become less aggressive to support macro and FX policies.

Eurobond premium required for fiscal slippage risk

We expect large and regular sovereign Eurobond issuance to support FX reserves and domestic liquidity but to weigh on regional bond spreads if risk appetite does not hold up or fiscal balance slips. EMBIG index inclusion is unlikely, in our view. Saudi forwards, CDS and rates are likely to stay under pressure due to issuance and tight liquidity.

Commodities: NTP adds to medium-term oil tightness

The NTP suggestion that production capacity is maintained until 2020 reinforces our conviction of medium-term oil market tightness. The NTP gas production target that could displace domestic crude demand and boost export capacity is challenging.

Equity Strategy: six investible themes on the back of NTP

We see a number of investible themes emerging from the NTP which investors can use to identify potential beneficiaries. These themes include rising availability of affordable housing, increased access to healthcare, down-trading as the consumer comes under pressure, a surge in telecom infrastructure and significant opportunities in the downstream petrochemical arena. Buy-rated names with access to these themes include: **Al Hammadi**, **Savola**, **Al Othaim**, **STC**, **Zain KSA** and **SABIC**.

Partial NTP success & MSCI inclusion could drive rerating

The Saudi market trades on a 12m fwd P/E of c.13x, an 11% discount to the long-term average and its lowest premium to GEMs since 2010. We believe that with earnings momentum gradually reaching an inflection point a relatively negative outlook is already being priced in. Given our view that oil prices will gain strong momentum in 2017, even a partial success of the NTP along with CMA market reforms to expedite inclusion in the MSCI EM index could be sufficient to improve confidence and thus drive a rerating.

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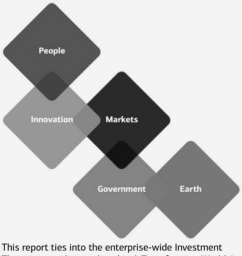
A Transforming World



This report ties into the enterprise-wide Investment Themes recently introduced in A Transforming World. In particular, the Saudi National Transformation Plan is likely to span the themes of Markets (Frontier), Government (Reform) and Earth (Energy Efficiency)

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Macro: charting the way forward

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The Saudi Vision 2030 and National Transformation Plan (NTP) present a comprehensive roadmap for change and augur for committed diversification efforts, in our view. Announced reforms can help sustain higher potential growth if fully realized as new sectoral sources of growth are developed. Positively, the NTP borrows elements from other successful strategic case studies. Still, we find a number of targets ambitious or unrealistic on the fiscal and diversification fronts, and the sequencing and details of the fiscal measures are left nebulous.

In terms of the other pillars of the macro view, namely energy and Fx policy, the NTP presents a mixed picture, in our view. Energy policy is likely to be less aggressive, as the NTP suggests a constant oil production capacity. To remain consistent with the targeted government debt accumulation path, we estimate that oil prices have to average at least US$50/bbl in 2016-20 along with no growth in spending (excluding the additional cost of NTP initiatives). Partial implementation could require oil prices of cUS$65/bbl.

Fiscal consolidation remains imperative to support the Fx peg, in line with stability and economic imperatives. However, as diversification progresses, the case for increased Fx flexibility to support competitiveness could likely gradually take shape. Policy-making growth-focused plans may conflict with needs to deflate Fx demand in the economy.

Towards better governance

The comprehensive economic blueprint unveiled by the Saudi Vision 2030 and the National Transformation Plan (NTP) confirms the economic reform credentials of the current administration. It is likely to improve government culture, accountability and transparency, in our view. The NTP will be implemented across 24 government bodies and has been presented through a number of press conferences with high-level ministerial presentations. The Governance Framework details steps to institutionalize and coordinate implementation through restructuring the government. It proposes a number of committees and bodies to report to the Council for Economic and Development Affairs (CEDA). It also introduces an escalation mechanism to rapidly resolve bottlenecks, which could see matters escalated to CEDA in 42 days.

A wide-ranging policy-making reshuffle

In line with ongoing Saudi Vision 2030 implementation efforts, a wide-ranging restructuring of the Saudi Cabinet and government bodies was announced in May to drive change in the government. King Salman issued 51 Royal Decrees restructuring the Cabinet, various government bodies and appointing a number of officials into various government roles. A statement concurrently issued by the Royal Court suggested these changes are in line with the recently announced Saudi Vision 2030 and aim to support its implementation. This follows from the January 2015 restructuring of the bodies affiliated to the Council of Ministers, which saw the creation of CEDA and the Council for Political and Security Affairs. We list a few major changes below.

New Oil Minister represents technocratic experience and policy continuity

The appointment of Khalid Al-Falih to the Ministry of Energy, Industry and Mineral Resources is not surprising, given that former Minister of Petroleum and Mineral Resources Al-Naimi has previously suggested he was approaching retirement due to old age. Al-Falih's appointment continues the tradition of non-Royals heading the Ministry, while simultaneously holding the Chairmanship role of Saudi Aramco. Furthermore, according to local press, Al-Falih appears close to Deputy Crown Prince Mohamed bin Salman, and his appointment likely confirms the recently assertive Royal influence over energy policy, in our view. New Minister of Energy, Industry and Mineral Resources Al-Falih's past official pronouncements are consistent with stable Saudi energy policy, in our view.

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Expanded role for the Oil Ministry under Vision 2030

The Ministry of Petroleum and Mineral Resources has been expanded to become the Ministry of Energy, Industry and Mineral Resources. It will be dedicated for energy, in addition to expanding to encompass responsibilities relating to electricity and industry. It will also undertake the management of the National Industrial Cluster Development Program (NICDP). The new Minister will chair the board of directors of the Royal Commission for Jubail and Yanbu, the Industrial Development Fund, the Saudi Organization for Industrial Estates and Technology Zones, the Saudi Geological Survey, the King Abdulaziz City for Science and Technology, the Saudi Exports Development Authority and the King Abdullah City for Atomic and Renewable Energy.

Energy sector liberalization drives non-oil diversification

The wider role for the Ministry of Energy, Industry and Mineral Resources is in line with the expanded industrial responsibilities foreseen for Saudi Aramco in the Vision 2030. It may also suggest a continued desire to liberalize the energy sector. The National Industrial Cluster Development Program (NICDP), established in October 2012 by the Ministry of Petroleum and Mineral Resources and the Ministry of Commerce and Industry, could likely gain further importance in the industrialization strategy adopted in the Vision 2030. The NICDP will be managed by the Ministry of Energy. It seeks to leverage Saudi Arabia's comparative advantage in energy, petrochemicals and minerals to create sustainable export oriented industries, initially focused on the automotive, construction material, appliances, metal processing and flexible packaging sectors.

Restructuring the Cabinet and other government bodies

The Ministry of Commerce and Industry will become the Ministry of Commerce and Investment and sees the appointment of a new Minister. The new Minister will chair the board of directors of the General Authority for Investment, the General Authority for Small and Medium Enterprises and the Saudi Standards, Metrology and Quality Organization. The Ministry of Labor will be merged with the Ministry of Social Affairs to form the Ministry of Labor and Social Development, and sees the appointment of a new Minister. The Ministry of Water and Electricity has been disbanded. The Ministry of Agriculture was renamed the Ministry of Environment, Water and Agriculture and expands its responsibilities into these areas. Two new Ministers for Transport and Health were appointed. The Ministry of Hajj has been renamed the Ministry of Hajj and Umrah and sees the appointment of a new Minister.

The Saudi Fund for Development will now report to the Council for Economic and Development Affairs. The General Authority for Entertainment and the General Authority for Culture have been created. The Department of Zakat and Income Tax was renamed the General Authority for Zakat and Income, and will report to the Ministry of Finance.

New Central Bank Governor maintains commitment to USD peg

Saudi Arabian Monetary Agency (SAMA) Governor Al-Mubarak has been replaced in his post by SAMA Deputy Governor for Research and International Affairs Dr. Al-Kholifey. A number of officials were also appointed into various government and advisory roles. New SAMA Governor Al-Kholifey's past policy pronouncements suggest continued commitment to the USD peg.

Watch the Saudi Fund for Development

The Saudi Fund for Development (SFD) new direct link to the Council for Economic and Development Affairs likely concentrates further authority in the Deputy Crown, in our view. Given that the Public Investment Fund (PIF) last saw similar links being established prior to plans being made for it to be turned into a Sovereign Wealth Fund (SWF), this could suggest further strategic changes may take place at the SFD.

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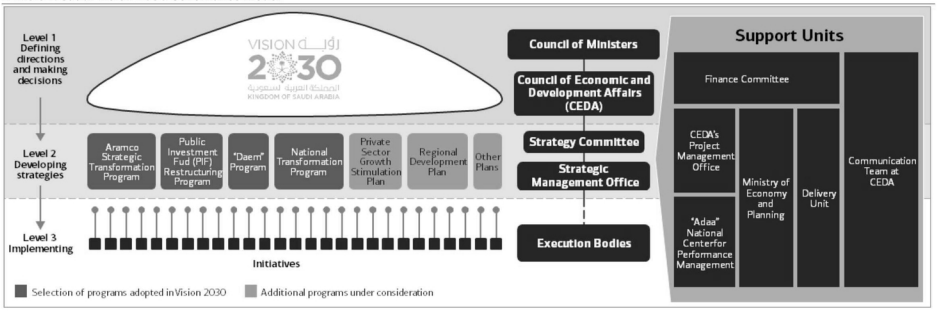
Exhibit 1: Saudi Vision 2030 Governance Model



Source: Saudi Vision 2030

A web of Strategic Programs

Saudi Vision 2030 incorporates a number of Executive Programs and initiatives, with implementation carried out by several government entities. The Vision continues to centralize decision-making into CEDA, chaired by Deputy Crown Prince Mohammed bin Salman, and reporting to the Council of Ministers. The Ministry of Economy and Planning also retains an important role, with lower emphasis being put on the Ministry of Finance. The Project Management Program also suggests emphasis on ongoing review of capital expenditures, whereby existing review served to examine their approval process, and control their level. From a macro perspective, the three most important programs for now are: a) the re-shaping of the Public Investment Fund (PIF) into a US$2trn Sovereign Wealth Fund (SWF); b) the new corporate strategy for Saudi Aramco to transform it into an energy and industrial conglomerate; and, c) the National Transformation Plan (NTP) which encompasses medium-term growth boosting initiatives and fiscal consolidation measures (alongside the Fiscal Balance and Privatization Programs). We discuss these three elements in turn below.

Table 1: Strategic Programs introduced by the Saudi Vision 2030

Strategic Program	Comment
Government Restructuring Program	Supreme Councils have already been implemented, and the Council of Political and Security Affairs and the Council of Economic and Development Affairs (CEDA) have been established
Strategic Directions Program	Strategic directions determined by state agencies and approved by the government
Regulations Review Program	Several laws have been reviewed or enacted already such as the Company Law, the Non-Governmental Organizations Law, the White Land Law, and the General Authority for Endowments (Awqaf) Law
Performance Measurement Program	Center for Performance Management of Government Agencies has been established
Human Capital Program	Aims to measure, assess, analyze and support the efficiency of civil service
Program for Strengthening Public Sector Governance	Strategic Management Office reporting to CEDA as well as a Decision Support Center at the Royal Court are to be established
Strategic Partnerships Program	Aims for stronger ties with economic partners to enhance exports
"Daem" Program	Aims to enhance the quality of cultural activities and entertainment
Private Sector Growth Stimulation Program	Under consideration
Regional Development Program	Under consideration
Fiscal Balance Program	Likely target of achieving fiscal balance by 2020
Project Management Program	Expert Project Management Offices (PMOs) and a Central Delivery Unit have been established
Saudi Aramco Strategic Transformation Program	Aims to position Saudi Aramco as a leader in more than one sector
Public Investment Fund (PIF) Restructuring Program	Aims to transform the PIF into the largest Sovereign Wealth Fund (SWF) in the world
Privatization Program	Comprehensive privatization program; targets under study
National Transformation Plan Program	Interim Key Performance Indicators (KPI) targets to achieve by 2020

Source: Saudi Vision 2030, BofA Merrill Lynch Global Research

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Table 2: Initiatives introduced by the Saudi Vision 2030

Initiative	Current	Target
Religious tourism		
Number of yearly Umrah visitors per year (mn)	8	30
Building the largest Islamic museum in the world	-	-
Culture		
Number of Saudi heritage sites registered with UNESCO	4	8
Number of Saudi cities recognized in the top-ranked 100 cities in the world	0	3
Household spending on cultural and entertainment activities (%)	2.9	6
Social		
Average life expectancy (years)	74	80
Unemployment rate (%)	11.6	7
Female labour force participation (%)	22	30
Household savings ratio (% of household income)	6	10
Ranking in the Social Capital Index	26	10
Ratio of individuals exercising at least once a week (%)	13	40
Number of volunteers per year	11,000	1,000,000
Localization		
Localization of oil and gas sectors (%)	40	75
Localization of defence industry (%)	2	50
Renewable energy value chain (%)	-	-
Sovereign Wealth Fund		
Public Investment Fund assets (SAR bn)	600	7,000
Economy		
Global ranking of the economy in terms of size	19	15
Ranking in the Global Competitiveness Index	25	10
Ranking in the Logistics Performance Index	49	25
Private sector contribution to GDP (%)	40	65
Foreign Direct Investment (% of GDP)	3.8	5.7
Non-oil exports share in non-oil GDP (%)	16	50
SME contribution to GDP (%)	20	35
Non-profit sector contribution to GDP	<1	5
Improving the business environment and pursuing public-private partnerships	-	-
Rehabilitating economic cities and restructure King Abdullah Financial District	-	-
Establishing special zones such as logistic, tourist, industrial and financial ones	-	-
Revise energy subsidies and redirect support to eligible citizens and economic sectors	-	-
Ease restrictions on ownership and foreign investment in the retail sector	-	-
Fiscal		
Non-oil government revenue (SAR bn)	163	1,000
Governance		
Ranking in the Government Effectiveness Index	80	20
Ranking in the E-Government Survey Index	36	5

Source: Saudi Vision 2030

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Public Investment Fund to gain prominence

The restructuring of the Public Investment Fund (PIF) is likely to allow greater focus on achieving a diversified foreign asset base which could support in turn the build-up of non-oil revenues. According to Deputy Crown Prince Mohammed bin Salman, government ownership of Saudi Aramco would be transferred to the PIF, which will be transformed into a SWF that will look to increase its overseas assets (from 5% of total to 50% of total by 2020) following its recapitalization and the proceeds of Aramco IPO. The PIF would hold on-paper a vast amount of wealth post-IPO (US$2trn, according to the Deputy Crown Prince, the bulk of which would be Saudi Aramco) as ownership of Saudi Aramco is transferred to the PIF, but it would only be able to deploy the cash proceeds of the monetized Aramco stake in the near-term, in our view. We think the PIF's transformation is still at a relatively early stage for now.

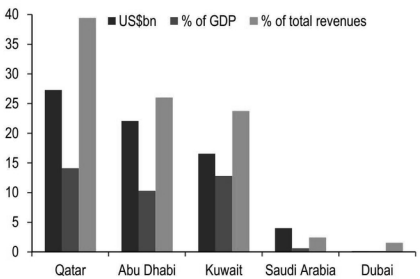
Room to grow PIF stature and budget contribution

The restructuring of the PIF is likely to allow further diversification of foreign assets, which will in turn increase the share of investment income in the budget over time. We estimate that in 2015 investment income transferred to the budget stood at US$9.9bn (1.5% of GDP), which entails transfers of US$4bn from the PIF and US$5bn from SAMA. These transfers pale in comparison to the estimated budgetary contributions among main GCC peers. We estimate that the rate of return (investment income) on foreign assets of SAMA, government entities and the private sector averaged c2% over the past 8 years, which already suggests some exposure to riskier asset classes, in our view. As the PIF gains importance, it will become more prominent in the examination of the breakdown of the Saudi Net International Investment Position .

Transitioning to an Abu Dhabi model

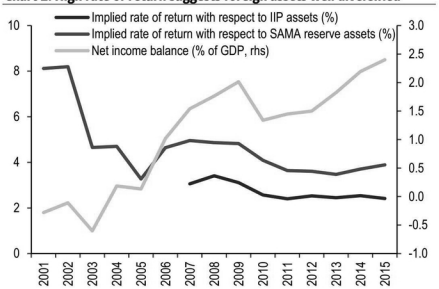
It will be interesting to see how the restructuring of the PIF into an SWF works out in practice. We hypothesise that it may be that, on top of the monetization of Aramco's stake sale, PIF could get a portion of the assets of SAMA. In this scenario, we would effectively transition to the Abu Dhabi and Kuwait model where the central bank holds little reserves and non-transparent SWFs are what matters both in terms of flow and stock. Foreign assets purchases of the PIF would also have to be managed within the overall Balance of Payments (BoP) framework as they could lead to drains on SAMA reserves in the near term. Over time, Saudi Arabia could decide to emulate the Norway model, which would entail a more prudent use and conduct of fiscal policy, in our view.

Chart 1: PIF budget contributions small versus GCC SWF contributions



Source: Haver, IMF, Saudi Ministry of Finance, BofA Merrill Lynch Global Research. 2015 data, Investment income and transfer of profits of public entities for Kuwait. Investment income from public enterprises (incudes Qatar Petroleum's net income) for Qatar.

Chart 2: High rate of return suggests foreign assets well diversified



Source: Haver, BofA Merrill Lynch Global Research. Implied rate of return on SAMA reserve assets simplistically assumes all investment income is earned by SAMA (instead of being earned by SAMA, government entities and the private sector).

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PIF largely a domestic inward-looking entity until recently

The IMF reports that the PIF had assets of 11.1% of GDP in 2014 (c.SAR310bn). PIF has foreign assets of SAR14.1bn as of end-2015. It has outstanding loans of SAR103.9bn as of 3Q15 (excluding electricity loans of SAR14bn that PIF administers). According to Bloomberg, PIF had stakes in publicly listed companies on Tadawul worth SAR934bn as of April 2016. According to the MoF, PIF held equity worth SAR63.3bn in 41 Saudi companies in total at end-2011, as well as stakes worth SAR14.9bn in a number of pan-Arab corporations.

In July 2014, the cabinet authorized the PIF to establish companies inside and outside Saudi Arabia, alone or in partnership with other institutions from the public or private sectors. It also bought a US$1.1bn stake in a South Korean company and recently announced in early June it took a US$3.5bn stake in Uber, denying in the process that it was considering a US$3bn loan to fund the acquisition. PIF has been asked to co-invest US$10bn in Russia or the Middle East with the RIDF. Note that PIF has established Sanabil investments with SAR20bn in capital. The PIF has paid dividends to the budget last year (SAR15bn). It now reports directly to the Council of Economic and Development Affairs headed by the Deputy Crown Prince, after reporting to the Ministry of Finance in the past.

JASTA bill not a hurdle for further Saudi investment in the US

We expect that the deep and liquid US financial markets will remain a prominent destination for Saudi foreign asset holdings. The potential passage of the "9/11" bill (Justice Against Sponsors of Terrorism Act, JASTA) in US Congress raises the possibility that Saudi Arabia would choose to liquidate up to US$750bn in assets in the US, according to Saudi Foreign Minister Adel al-Jubeir. A forced and rapid liquidation of US-based Saudi foreign assets may expose SAMA and other government entities to mark-to-market losses, and require changes to Fx reserve management

The language of the JASTA bill as it currently stands does not suggest an imminent Saudi sell-off of US assets, in our view. The "Stay of Actions Pending State Negotiations" section inserted into the bill allows a stay to be granted for an indefinitely renewable 180-day period. This would be subject to court petition by the Attorney General and repeated certification by the Secretary of State that the US is "engaged in good faith discussions with the foreign state defendant concerning the resolution of the claims against the foreign state". The certification thus depends on the current and future US administration foreign policy inclinations, in our view. Separately, we note that the White House spokesman said US President Obama did not support the legislation and likely would not sign it. (A potential presidential veto may however still be overruled if Congress assembles the necessary two–thirds vote of each house). We continue to expect a close relationship between the US and Saudi Arabia given the confluence of interests in a broad range of matters.

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Table 3: Breakdown of Saudi Arabia Net International Investment Position (US$bn)

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Net International Investment Position	**380**	**471**	**435**	**479**	**585**	**685**	**763**	**792**	**703**
% of GDP	91	91	101	91	87	93	103	105	108
Net Foreign assets (excluding SAMA)	74	28	24	34	41	28	37	59	87
% of GDP	18	5	6	6	6	4	5	8	13
Assets	**495**	**631**	**636**	**708**	**824**	**936**	**1,028**	**1,069**	**993**
Non-reserve assets	190	188	226	262	280	279	302	337	376
by holder:									
Investment funds	7	4	4	5	5	5	6	8	7
Commercial banks	39	41	56	52	56	57	56	67	84
Public Investment Fund (PIF) foreign investment	1	2	2	4	4	5	4	4	4
Saudi Fund for Development (SFD) cumulative loan disbursements	6	6	6	7	7	7	8	8	-
Public Pension Agency (PPA) and General Organization for Social Insurance (GOSI) net foreign assets	-	49	-	-	-	98	112	-	-
of which, managed by SAMA (e)	43	48	51	59	65	69	75	80	78
PPA net foreign assets	-	24	-	-	-	63	72	-	-
GOSI net foreign assets	-	25	-	-	-	35	40	-	-
Development funds and other government (exc. PPA/GOSI) entities' foreign assets managed by SAMA (e)	15	17	18	20	22	23	25	27	26
Other	-	69	-	-	-	85	92	-	-
by instrument:									
Direct investment abroad	17	20	23	27	30	34	39	45	63
Portfolio investment	105	99	122	146	158	168	178	199	202
Equity securities	53	50	59	79	82	92	99	111	109
Debt securities	52	48	63	68	77	75	79	88	94
Other investment	68	69	82	90	92	77	85	93	111
Loans	3	4	4	3	3	2	2	1	1
Currency and deposits	55	63	73	76	78	69	76	85	105
Other assets	10	3	5	11	11	6	7	6	5
SAMA Reserve assets	306	443	410	445	544	657	726	732	616
Currency and deposits	93	132	111	117	148	197	191	187	204
Foreign securities	211	308	286	315	380	444	519	532	400
Other assets	2	3	13	13	16	16	15	13	12
Liabilities	**-116**	**-160**	**-201**	**-228**	**-239**	**-251**	**-265**	**-278**	**-289**
Direct investment in reporting economy	-73	-113	-148	-176	-187	-199	-208	-216	-224
Portfolio investment	0	-3	-4	-4	-6	-10	-17	-17	-17
Equity securities	0	0	0	0	0	-9	-15	-15	-15
Debt securities	0	0	0	0	0	-1	-2	-2	-2
Other investment	-42	-44	-49	-48	-46	-42	-40	-45	-48
Loans	-13	-14	-13	-13	-12	-11	-9	-10	-12
Currency and deposits	-28	-28	-25	-25	-23	-20	-19	-25	-26
Other assets	-1	-1	-11	-10	-11	-11	-11	-11	-11
memo:									
Identified Saudi Arabian and Middle Eastern holdings in the US									
Saudi Arabia US Treasury (UST) holdings	51	46	83	69	68	76	80	91	109
Long-term securities	50	45	82	68	67	74	78	88	107
Short-term securities	1	1	1	1	1	2	2	3	2
Saudi Arabia holdings of US equities	45	42	31	36	53	65	68	78	52
Saudi Arabia holdings of US Agency debt securities	8	42	14	7	5	5	7	6	6
Long-term securities	8	41	14	7	5	5	7	6	6
Short-term securities	0	1	0	0	0	0	0	0	0
Saudi Arabia holdings of US corporate debt securities	7	14	17	12	12	9	15	19	15
Long-term securities	5	9	11	9	8	6	10	13	13
Short-term securities	2	5	6	3	4	3	5	5	3
Middle East Foreign Direct Investment (FDI) position in the US (cost basis)	9	9	10	8	10	11	12	11	-
Middle East oil exporters gross claims on US banks	81	122	106	101	136	132	134	129	120
Saudi Arabia deposits in Bank for International Settlements (BIS) reporting banks									
Cross-border deposits with BIS reporting banks	163	180	169	167	188	244	224	210	212
of which, implied deposits from banks and others	102	142	128	113	135	180	174	158	170
of which, deposits from nonbanks	60	39	41	54	53	64	50	52	42
Saudi Fund for Development									
Cumulative signed loans	7	8	8	9	10	11	11	12	-
Cumulative disbursements	6	6	6	7	7	7	8	8	-
Government entities foreign assets managed by SAMA off-balance sheet	*58*	*66*	*69*	*79*	*87*	*92*	*100*	*107*	*104*
Deposits with banks abroad	4	5	3	2	2	6	13	10	5
Foreign securities	55	61	66	77	85	85	87	97	98

Source: Haver, SAMA, IMF, SFD, BofA Merrill Lynch Global Research. Middle East oil exporters consist of Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

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Historic energy sector liberalization

Partial privatization of energy sector assets could represent one of the cornerstones of the ambitious medium-term diversification strategy, and, if confirmed, serve as a highly visible and historic milestone. Such privatizations could ease key macro concerns regarding unsustainable debt accumulation and Fx reserves drawdown. We believe it would also confirm the government's macro reform credentials, its preparedness for a prolonged period of low oil prices and likely signal no near-term energy policy capitulation. The NTP suggestion of a flat production capacity through 2020 suggests less aggressive market share strategy, in our view.

Privatization of energy sector could start by 2018

In a recent interview with Bloomberg, Saudi Deputy Crown Prince Mohammed bin Salman outlined an array of measures the Saudi government could introduce to help diversify the economy, reduce its reliance on the hydrocarbon industry and ultimately support medium-term fiscal consolidation in a low oil price environment. Amongst these measures, the Deputy Crown Prince included a potential Initial Public Offering (IPO) of Saudi Aramco (at the parent level, and including various subsidiaries). With close to 250bn bbls of oil reserves, more than 10mn bbls per day of production and the world's 4th largest gas reserves, Saudi Aramco is the leader in hydrocarbon access among state owned, private and public Oil & Gas (O&G) companies alike. Saudi Aramco is the world's largest Oil & Gas Company by production and arguably the Kingdom's most important asset. Specifically, he outlined a plan that would see "less than 5%" of the company being sold to investors on the Saudi stock exchange no later than 2018 (but potentially as soon as 2017). Furthermore, he indicated the Kingdom is seeking to transform Aramco into an "energy-industrial company". The high profile stake sale would provide a highly visible anchor to diversification efforts and capitalize its newly restructured SWF.

Energy assets form a major and strategic sector for the economy

It is hard not to understate the central role the energy sector plays in the Saudi economy. The hydrocarbon sector represented 43.0% of the economy in real terms in 2015. Deputy Crown Prince Mohammed bin Salman suggested a US$2trn price tag for Saudi Aramco in his Bloomberg interview. Aramco is deeply intertwined with the Saudi state, and its workforce Saudization has increased over the years to 83%. Furthermore, it is the foundation of its state's domestic and international energy policy. As such, a decision to partially privatize the energy sector will be a momentous one to be carefully examined by the technocratic and political leadership, in our view.

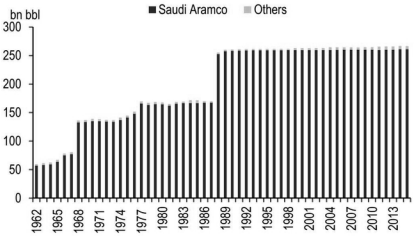
More questions than answers at this stage

Deputy Crown Prince Mohammed bin Salman's initial suggestion in an interview with The Economist that a Saudi Aramco IPO could be considered has raised market expectations. Ensuing comments from Aramco's management did not make clear whether a listing would occur, and if so, in what form (upstream versus downstream), although the Deputy Crown Prince's subsequent Bloomberg interview suggested further impetus being given to studying the matter.

A listing of the entity itself may force much more transparency regarding hydrocarbon reserves (broadly unchanged for several years), lifting costs (local crude oil sales suggest cUS$5/bbl if no loss is incurred) and the fiscal regime (estimates in the press have suggested that Aramco's profits are taxed at 85%, with royalties set at 20%, but we also note from fiscal data that the fiscal transfer ratio in oil revenues to the Ministry of Finance appears to drop in years of low oil prices). It may also conflict with non-commercial ventures or strategic aspects of Saudi Aramco. This would include the maintaining of spare capacity and state policy matters (including energy policy). Note for instance that the US is the second regional destination for Saudi crude oil exports (17.5% of total Saudi crude oil exports) behind Asia. This was due to a strategic geopolitical decision to remain an important crude oil supplier to the US and was achieved through the buying of stakes in refineries in 1988.

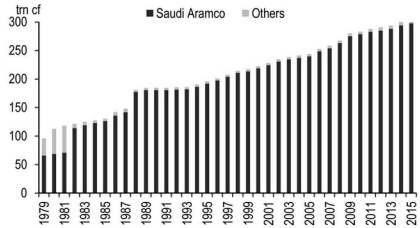
HOUSE_OVERSIGHT_016120

Chart 3: Saudi Arabia proven crude oil reserves



Source: SAMA, Bank of America Merrill Lynch Global Research

Chart 4: Saudi Arabia proven gas reserves



Source: SAMA, Bank of America Merrill Lynch Global Research

Oil sector privatization could slow debt build-up and support Fx reserves

Potential energy sector asset partial privatization could raise a substantial amount for the Saudi government, in our view. A share sale would be a non-debt creating financing flow for the budget, which would lessen the need to borrow domestically or externally. A share sale could also increase Saudi Arabia's ability to project soft power and influence regionally and internationally. However, it would only support the build-up of Fx reserves in the case of foreign investor participation. Assuming a US$2trn valuation suggested by the Deputy Crown Prince as the value for the SWF, the vast majority of which would be Aramco through a possible 5% listing, such a listing could raise up cUS$100bn, which would represent the current annual government borrowing requirements and associated Fx reserves drawdown. We expect further administered energy price adjustments over the next five years, which should increase state revenues, in our view.

A share sale may also facilitate international borrowing on the back of Saudi Aramco's balance sheet. Saudi Aramco also announced it would look to set up a corporate debt program to fund its NTP initiatives, although issuance does not appear to be an immediate prospect. A corporate debt program, alongside a sovereign one, could allow the government to simultaneously tap a new pool of liquidity through corporate bond investors, upstream proceeds if needed and support Fx reserves. This could be achieved without impacting central government debt ratios and without saturating the government debt issuance room with sovereign debt investors. Saudi Aramco raised a US$10bn syndicated loan in late March 2015 in part to fund acquisitions. The loan replaced US$4bn in existing facilities agreed to in 2010, and includes a US$6bn five-year tranche with two 1-year extension options, a US$1bn 1-year renewable facility, a non-interest bearing SAR7.5bn (US$2bn) five-year tranche with two 1-year extension options and a SAR3.75bn (US$1bn) 1-year tranche renewable yearly.

Very roughly, taking the US$2trn Deputy Crown Prince potential valuation for Aramco, and assuming an optimal 10% net-debt-to-equity medium-term target, it would suggest that Aramco could manage leverage of up to US$200bn (c30% of GDP) in domestic and external debt on its balance sheet. Within a corporate setting, possible higher gearing needs to be justified to shareholders and could reflect financing of acquisitions or NTP costs. From a macro angle, international issuance would support Fx reserves.

Three aspects of energy policy to consider going forward

Energy sector privatization is likely to raise questions on the future path of energy policy, though we believe the latter will stay the course for now. We believe that are three aspects that are central to energy policy in Saudi Arabia: a) competition for global market share in upstream operations; b) future investment decisions and maintaining of spare capacity buffer; and c) integration and expansion of downstream ventures to create domestic jobs, secure captive crude demand and make operations less volatile.

HOUSE_OVERSIGHT_016121

Targeting a stable oil price

As a matter of Saudi policy, we would expect a preference for oil market stability over volatility, in line with recent official pronouncements. Although volatility makes it more difficult for high cost unconventional producers to operate, volatility is also damaging for Saudi Arabia and long-term planning domestically. For instance, no budget was announced for 1986 due to uncertainties in the world oil market, with monthly current appropriations set at one-twelfth of estimated actual expenditures for the prior year. We think Saudi authorities view possible eventual sharp upward price spikes in the oil price as damaging to both oil-consuming and oil-producing countries.

Future investment decisions will be critical for oil prices

Spare capacity is an important policy parameter for Saudi Arabia. In addition to its influence on prices through its ability to adjust production, Saudi can decide on the pace of its reserves development which would potentially affect future supply. There are distinct trade-offs in this decision. If Saudi Arabia is producing at close to its maximum capacity, it will have little control over sharp upside movements in oil prices. If excess capacity is large, oil prices are likely to be under downward pressure.

In the near-term, given the uncertainty in the market, in our view, there is likely little incentive for Saudi Arabia to embark on a program to invest and increase capacity from the current level. New investments may still be made to offset declines in existing fields. Over time however, our commodities research medium-term oil balances suggest that Saudi's spare capacity would be eroded over time unless further increases in spare capacity take place. Our BofAML commodities research medium-term supply-demand balances suggest an increased call on OPEC and need to increase production capacity. In 2004-09, Aramco invested cUS$100bn into its largest-ever capacity expansion program, which increased total capacity from 10mn bpd to 12.5mn bpd. For now, Aramco has suggested it will not slow down its hydrocarbon capex program for the next three years as cuts were achieving through savings in drilling costs and supplier discounts.

Energy policy is likely to be less aggressive going forward

We expect a less aggressive energy policy going forward, particularly as the NTP suggests a constant oil production capacity and an increase in gas production domestically. This is in line with Saudi Minister of Energy, Industry and Mineral Resources Al-Falih's pronouncements during the June Ordinary OPEC meeting. While his comments served to project increased OPEC institutional credibility and increased rapprochement with fellow OPEC members, he suggested that Saudi Arabia will remain responsive to customer needs but dismissed fears that increasing Saudi market share would take place in an aggressive manner (that could drive prices lower again).

Downstream operations - increased focus

Saudi Aramco's downstream integration drive is likely being pursued for two core reasons: (1) to support demand for Saudi crude (placing own crude in own refining capacity) and (2) a risk reduction mechanism in a highly volatile oil environment (having an integrated value chain allows capture of margins from well to the forecourt, promoting stability). In reflection, Saudi Aramco is building highly sophisticated refineries domestically, in addition to already completed joint-ventures and stakes in refineries abroad (China, US, Japan, South Korea, Indonesia). Domestic joint-venture (JV) refineries Satorp and Yasref added 400k bpd each of capacity in 2H14. With the completion of the fully-owned Jazan 400k bpd refinery in 2018/19, overall total refinery capacity would stand at 5.7mn bpd, of which Saudi Aramco's share would be 3.3mn bpd. This would allow Saudi Arabia to guarantee security of demand for its heavy crude, increase domestic job creation and diversification, build an export base of refined products (likely middle distillates to the EU) and lower imports of refined products.

HOUSE_OVERSIGHT_016122

National Transformation Plan: many promises, few details

The National Transformation Plan (NTP) released by the Saudi government is a further step towards execution of Saudi Vision 2030 through a set of ambitious interim targets to achieve by 2020 by 24 government bodies. The NTP is a comprehensive program encompassing medium-term growth boosting initiatives and fiscal consolidation measures. The sequencing and details of the fiscal measures are however still left nebulous. Implementation of growth-boosting initiatives will require a challenging crowding in of private sector investment, particularly from domestic sources.

The NTP is likely to introduce a number of one-off supply-side shocks to inflation through its fiscal or labor measures, which could negatively impact Real Effective Exchange Rate (REER) competitiveness. Discretionary consumption growth and real incomes are likely to remain under pressure. We find the diversification measures encouraging, although they appear too ambitious to be met within the time frame envisaged in the NTP, in our view. The focus on diversification could introduce medium-term incentives to adopt a more competitive exchange rate, while also detracting from the binding fiscal constraint under which the government has to operate. Energy policy is likely to be less aggressive and support oil prices. Fiscal targets are difficult to reach, but medium-term oil prices of at least US$50-65/bbl could support NTP progress.

Table 4: Selected macro Key Performance Indicators (KPIs) under the National Transformation Plan

Government entity	Key Performance Indicator (KPI)	Unit	Baseline	2020 target	Regional b'mark	Global b'mark
Ministry of Finance						
	Total non-oil revenues	SARbn	163.5	530	10.9	691.0
	Budgeted salaries and wages	SARbn	480	456	N/A	N/A
	Salaries and wages as a percentage of the budget	%	45	40	30	12
	Approved projects according to criteria and timeline (% of total)	%	0	40	30	78
	Credit rating	-	A1	Aa2	Aa2	Aaa
	Government debt as percentage of gross domestic product (%)	%	7.7	30	35	54
	Total recorded non-oil assets	SARtrn	3	5	N/A	N/A
Ministry of Economy & Planning						
	Total revenue resulting from privatization projects	Under Study	Under Study	Under Study	N/A	N/A
	Value of water and electricity subsidy decrease	SARbn	0	200	N/A	N/A
	Percentage decrease in non-oil subsidy	%	0	20	N/A	N/A
	Value of private sector contribution to GDP	SARbn	993.3	Under Study	122.6	14,133.8
Ministry of Energy, Industry and Mineral Resources						
	Value of exports of non-oil commodities	SARbn	185	330	Under Study	Under Study
	Value of the mining sector's contribution to GDP	SARbn	64	97	13	262
	Local content in expenditure of public and private sectors	%	36	50	Under study	57
	Petroleum production capacity	mn bpd	12.5	12.5	3.8	11
	Dry gas production capacity	bn cf pd	12	17.8	5.7	16
	Refining capacity	mn bpd	2.9	3.3	1.1	1.9
Ministry of Labor and Social Development						
	Unemployment rate for Saudis	%	11.6	9	Under Study	5.8
	Cost of employment of Saudis compared to expatriates	%	400	280	N/A	N/A
	Proportion of female labor force	%	23	28	Under Study	Under Study
Ministry of Hajj and Umrah						
	Number of formal Hajj pilgrims (domestic and foreign)	mn	1.5	2.5	N/A	N/A
	Number of Umrah Pilgrims from abroad	mn	6	15	N/A	N/A
	Number of Umrah pilgrims (domestic and GCC nationals)	mn	Under Study	Under Study	N/A	N/A
Commission for Tourism and National Heritage						
	% contribution of tourism sector to GDP	%	2.9	3.1	4.9	5.4
Ministry of Civil Service						
	% decrease in the payroll and benefits expenditure	%	Under Study	20	Under Study	22
	% of workers reduction in the civil service sector	%	Under Study	20	Under Study	18
Saudi Arabian General Investment Authority						
	Foreign Direct Investment (FDI)	SARbn	30	70	45	481
	Time needed to issue work visas for new expat employees	Day	30	10	10	3
	Time needed to issue new business permits	Day	19	1	8	0.5

Source: National Transformation Plan

HOUSE_OVERSIGHT_016123

Ambitious diversification agenda is not without risks

Diversification initiatives will require material participation from the private sector. Vested interests and the large bureaucracy could act as a dampener on timely reform implementation going forward. The large size of the NTP program may mean some of its outcomes are internally inconsistent, in our view. Cultural and entertainment changes could be opposed by conservative or clerical factions. Slippage could occur due to execution risk or reform fatigue, particularly due to the socio-economic impact of fiscal consolidation. Any material changes to subsidies or wages could be difficult to implement in the absence of a social safety net. While fiscal consolidation measures are unprecedented in scope, they appear too ambitious or difficult to reach and may leave a financing gap. As such, the measures may still fall short if oil prices do not stabilize, which suggests a need for a less aggressive energy policy going forward, in our view.

Government leaders continue to show focus on delivery

The US visit of Deputy Crown Prince Mohammed bin Salman and finalization of various Memoranda of Understanding (MoUs) with prominent US corporates helps provide a highly visible anchor for foreign investment and instil business confidence in regards to government focus. It also helps boost the profile of the Deputy Crown Prince both domestically and internationally. This is in line with our view that the government is likely to target rapid implementation of several 'low-hanging' reforms to spearhead the program and boost confidence. Energy sector liberalization could also serve as another highly visible anchor to the reform program, in our view.

Table 5: Announced US corporates plans during the US visit of the Saudi Deputy Crown Prince

Company	Sector	Outcome
Six Flags	Entertainment	Company has been allowed to operate in Saudi Arabia
Pfizer	Pharmaceuticals	Company has been awarded a direct investment license
3M	Manufacturing	Company has been awarded a direct investment license
Dow Chemical	Chemicals	Company has been awarded a direct investment license
Microsoft	IT	Memorandum of Understanding signed
Cisco	IT	Memorandum of Understanding signed
Apple	IT	Discussions on entry to Saudi market possibly under way

Source: Press reports, Saudi Press Agency, BofA Merrill Lynch Global Research

Diversification drive is a step in the right direction

The comprehensive medium-term diversification drive introduced by the NTP follows the typical macro template, in our view. We discuss in a later section diversification lessons from Malaysia and Norway and conclude that the NTP contains elements from these successful case studies. In particular, it a) identifies key sectors with relatively high growth potential (mining, petrochemicals, manufacturing, retail and wholesale trade, religious and other forms of tourism, healthcare, real estate and finance); b), it starts to articulate supportive public sector industrial strategies, including through localization policies; and, c) it seeks to foster higher-value added in the economy through enhancements to processes, products and organizations.

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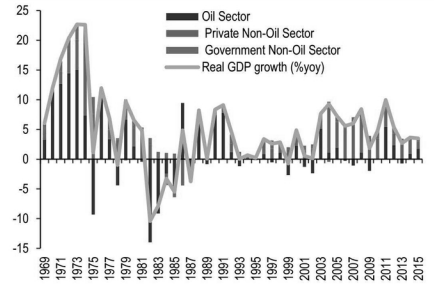
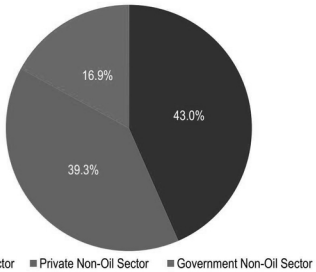
Chart 5: More sustained private non-oil sector growth needed in Saudi



Source: Haver, BofA Merrill Lynch Global Research. Series uses contributions to growth from real GDP data with 1999 base year prior to 2010.

Chart 6: Oil sector large; government controls 60% of real economy

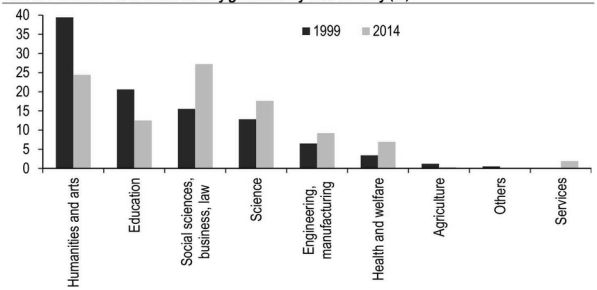


Source: Haver, BofA Merrill Lynch Global Research. Data as of 2015.

Human capital is critical and takes time to build

In our view, improvements to human capital, rather than business climate supply-side reforms, are the critical barriers to overcome. While building the appropriately qualified workforce takes time, Saudi Arabia has been making progress in this area. c25% of Saudi tertiary graduates complete humanities and arts programs, but this is down from 39.4% in 1999. Graduates from social sciences, business and law represented the largest share of graduates at 27.2% of total in 2014, up from 15.5% in 1999. Still, as we discuss in later sections, diversification prospects are mixed across sectors and will likely depend in part on providing the appropriate incentives to the private sector.

Chart 7: Distribution of Saudi tertiary graduates by field of study (%)



Source: UNESCO, BofA Merrill Lynch Global Research

Mobilizing domestic resources is key

The NTP makes clear that part of the NTP costs (40%) will need to be shouldered by the private sector. Out of a total estimated NTP cost of SAR447bn (US$119bn; 18.4% of GDP), the NTP implies that the private sector will need to contribute about SAR179bn over the coming five years (US$47.6bn; 7.4% of GDP). Implementation of growth-boosting initiatives will require a challenging crowding in of private sector investment. The NTP expects only a SAR40bn increase in the level of Foreign Direct Investment (FDI), meaning that the bulk of private sector investment could have to come from domestic sources. While the government investment is generally in retrenchment mode, the NTP may be suggesting that selective and strategic projects are likely to go ahead. Authorities have also suggested a number of projects could be structured as Public-Private Partnerships (PPP).

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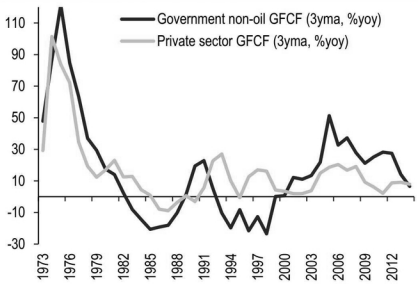
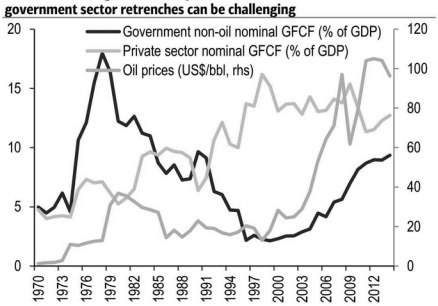
Chart 8: Saudi government non-hydrocarbon and private sector investment growth are relatively correlated



Source: Haver, BofA Merrill Lynch Global Research. GFCF refers to Gross Fixed Capital Formation.

Chart 9: Crowding in domestic private sector investment when the government sector retrenches can be challenging

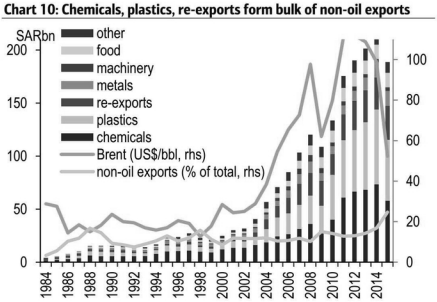


Source: Haver, BofA Merrill Lynch Global Research. GFCF refers to Gross Fixed Capital Formation.

Ambitious non-oil export and tourism targets, but little details

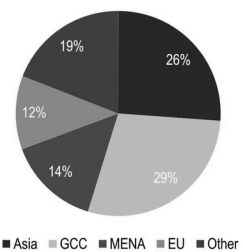
The NTP targets increasing non-oil exports by SAR145bn (US$38bn, 6.0% of GDP) to SAR330bn (US$88bn, 11.4% of 2020f GDP) over the next five years. Although implementation details are lacking, we anticipate that part of the increase could be linked to the higher mining output targeted. These would nevertheless be dependent on the global economic cycle. Higher exports of refined oil products, if all of the additional capacity to be installed by 2020 is exported, could add cUS$7.3bn to exports at current price levels (but not qualify towards non-oil exports targets under the NTP as they are classified as hydrocarbon exports). Currently, 61% of Saudi non-oil exports represents chemicals and plastics, and maintains a correlation with oil prices, and re-exports account for another 17% of total non-oil exports and have little added-value.

Chart 10: Chemicals, plastics, re-exports form bulk of non-oil exports



Source: Haver, BofA Merrill Lynch Global Research.

Chart 11: Non-oil exports are diversified in terms of destination



Source: Haver, BofA Merrill Lynch Global Research.

Likewise, the focus on religious tourism is appropriate given its importance in Saudi Arabia but NTP targets appear ambitious to us with a targeted 20%yoy CAGR increase in Umrah pilgrims. Religious tourism accounted for c40% of total tourist expenditure in Saudi Arabia in 2015, bringing in proceeds of SAR33.4bn (US$8.9bn; 1.4% of GDP). Note that, for balance of payment purposes, total tourism revenues stood instead at SAR37.9bn (US$10.1bn; 1.6% of GDP). The NTP targets would thus imply religious tourism external revenues/expenditures to increase to US$10-US$20bn (1.3-2.6% of 2020f GDP). This would be helpful on the external front but not a game changer on its own, in our view.

Merrill Lynch

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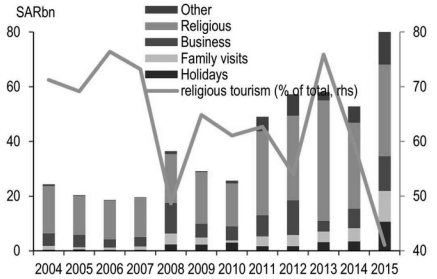
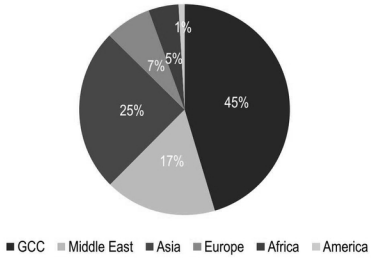
Chart 12: Breakdown of expenditure on inbound tourist trips



Source: SAMA, BofA Merrill Lynch Global Research.

Chart 13: Inbound tourist trips to Saudi Arabia by country of origin



Source: SAMA, BofA Merrill Lynch Global Research. Data as of 2015.

Mixed prospects for fiscal consolidation

The apparent redistribution of part of the proceeds of the flagship fiscal measures towards funding the NTP initiatives suggests that the fiscal consolidation efforts could fall short of the necessary requirement to narrow imbalances materially in the absence of a sustained oil price recovery. We calculate that the NTP targets a total net cumulative fiscal consolidation effort of SAR648bn (US$172.8bn) or c1% of GDP annually, assuming progressive and full implementation of the non-oil revenue targets.

Energy policy needs to support economic transformation

Energy policy is likely to be less aggressive going forward, particularly as the NTP suggests a constant oil production capacity as well as an increase in gas production domestically which could free up domestic crude for exports. To remain consistent with the targeted government debt accumulation path, we estimate that oil prices have to average at least US$50/bbl in 2016-20 along with no growth in spending from 2016 levels (excluding the additional cost of NTP initiatives but including implementation of the NTP non-oil revenue measures). Oil prices of at least cUS$65/bbl would be required if spending is not disciplined or revenue targets are missed by c50%, in our view.

Blueprint for fiscal measures lacks details

The approved NTP initiatives will have a total fiscal cost of SAR268bn (US$71.5bn; 11.6% of GDP) spread over five years (annually, SAR54bn equivalent to US$14.3bn or 2.3% of GDP). Government financing could represent 60% of total funding needs for the NTP initiatives, with total NTP costs of SAR447bn (US$119bn; 18.4% of GDP). Against that, the NTP envisages raising SAR366bn in non-oil revenues and cut the wage bill by 5% or SAR24bn (US$6.4bn or 1% of GDP). Non-oil revenue is seen rising to SAR530bn (US$141bn, 23% of 2016f GDP) by 2020 from SAR163.5bn (7% of GDP).

Wage bill measure unclear but may carry profound social implications

In an unprecedented austerity measure, the share of the wage bill in total spending would fall by 5ppt to 40% (SAR456bn, from SAR480bn) by 2020. It is yet unclear how this could be achieved in practice. Furthermore, note that the MoF budget announcement estimated the wage bill in 2015 to stand at SAR450bn, blurring the target. Privatizations of government entities are likely to lead to a natural drop in the public sector number of employees and wage bill. Yet we note that the Ministry of Civil Service has two Key Performance Indicators (KPIs) directly linked to a decrease in the payroll and benefits expenditure, and to a reduction in workers in the civil service sector. This would likely be a contentious and unpopular measure to implement, and its implementation and success appear challenging to us.

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Spending path is unclear and is flattish (excluding NTP costs) in the best case

The spending path targeted or assumed by the NTP is unclear and does not appear to match realized outturns. It may suggest that spending is likely to remain flattish, excluding NTP costs. However, the indicative level spending would settle at is around peak 2014 expenditures levels and well above the 2015 realized spending and 2016 budgeted levels. While 2015 spending could have been understated and may be revised higher, at least SAR88bn from the 2015 spending is non-recurrent as it relates to the one-off Saudi Royal edicts decreed upon King Salman's accession.

Going by the indicated 2020 target for the share of the wage bill in total spending, this would suggest that government spending is targeted at SAR1,140bn in 2020. This represents a 2.7% increase over peak 2014 spending levels and 16.5% increase over 2015 actual spending levels. Excluding the NTP annual costs, this suggests that government spending should still increase by 11% over 2015 levels and drop by 2% over 2014 spending in nominal terms.

In our view, given the lack of precise spending targets, one way of remaining consistent is to use the two NTP figures for wages and infer the NTP fiscal spending from the stated share of wages in total expenditures. This would suggest that fiscal expenditures would reach SAR1,140bn in 2020, from SAR1,067bn in the base year (unstated in the NTP). This is a 6.8% increase, but excluding the NTP costs, is just 1.8% higher. As such, in the best case scenario, we think the NTP suggests flattish spending, excluding NTP costs. If we instead take the NTP level of spending inferred to be the correct amount, this would materially widen the fiscal deficit by SAR190bn (8.0% of GDP) and would be deeply negative for the sustainability of the fiscal and Fx stance, in our view.

Fiscal adjustment burden shifts to raising revenue, oil prices and exports

The possible flattish spending implication of the NTP would tend to indicate that the bulk of the spending cuts are now beyond us. Government projects are likely to continue to be prioritized, likely according to their economic benefits and relevance to the NTP. Flattish spending will thus shift the burden of forthcoming fiscal adjustment on raising non-oil revenues, raising hydrocarbon exports and a sustained recovery in oil prices.

Table 6: National Transformation Plan-related spending across government entities (2016-2020)

	Cost (SARbn)	Cost (US$bn)	% of total
Ministry of Housing	59.2	15.8	22.0
Royal Commission for Jubail and Yanbu	41.6	11.1	15.5
Ministry of Education	24.4	6.5	9.1
Ministry of Health	23.1	6.1	8.6
Ministry of communications and IT	14.9	4.0	5.6
Ministry of Agriculture	13.9	3.7	5.2
Ministry of Water and Electricity	12.9	3.4	4.8
Saudi Commission for Tourism & National Heritage	10.5	2.8	3.9
King Abdulaziz City for Science and Technology	8.3	2.2	3.1
Ministry of Labor	7.9	2.1	3.0
General Presidency of Youth Welfare	7.8	2.1	2.9
Ministry of Transport	5.6	1.5	2.1
Ministry of Social Affairs	5.4	1.4	2.0
King Abdullah City for Atomic and Renewable Energy	5.2	1.4	1.9
Ministry of Commerce and Industry	4.3	1.1	1.6
Ministry of Municipality and Rural Affairs	4.2	1.1	1.6
Ministry of Finance	3.4	0.9	1.3
Ministry of Culture and Information	3.3	0.9	1.2
Ministry of Economy and Planning	3.3	0.9	1.2
Ministry of Justice	3.2	0.9	1.2
Ministry of Petroleum and Mineral Resources	2.7	0.7	1.0
Saudi Arabian General Investment Authority	1.1	0.3	0.4
Others	2.3	0.6	0.9
Total	268.4	71.6	100.0

Source: National Transformation Plan

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Focus on increasing non-hydrocarbon fiscal revenue could fall short of target

The breakdown of measures to raise non-oil revenues is not given. However, the tally is close to the US$100bn targeted in the Vision 2030 and is thus likely to include measures discussed then: hikes to administered energy prices, review of current levels of fees and fines, introduction of new fees, land tax (we estimate annual revenues of 1.5-2% of GDP in its first phase when fully implemented). In this regard, the NTP suggests forthcoming privatizations, imposition of taxes on harmful products (likely tobacco and soft drinks), introduction of a Value-Added Tax (VAT) for which we estimate annual revenues of up to 2% of GDP, implementation of a unified income tax and of an income tax on residents (although official comments later clarified there were no plans to tax nationals but stayed equivocal regarding expatriates).

Although there is no direct budgetary impact, water and electricity subsidies are targeted to decrease by SAR200bn. Non-oil subsidies are targeted to decrease by 20% by 2020. The latter, we believe, consists largely of subsidies for social and sports clubs, private education, private hospitals, and other agricultural subsidies. They were budgeted at SAR3.9bn (US$1.0bn; 0.2% of GDP) in 2016, down from SAR15.0bn (US$4.0bn; 0.6% of GDP) in 2015. A 20% cut to these on-budget non-oil subsidies would thus generate minimal savings of US$0.2-US$0.8bn (0.1-0.5% of GDP) depending if the reference base year was 2015 or 2016.

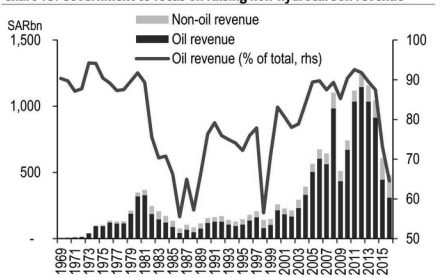
According to the Deputy Crown Prince pronouncements early in the year, medium-term plans are also likely to target the introduction of US$400bn of unutilized state assets (land, etc) to state-owned funds, with the latter in turn in charge of developing them into projects and companies than can be IPOed to the public. In our view, this may be linked to the Ministry of Finance assigned KPI of increasing total recorded non-oil assets (real estate, etc) from SAR3trn to SAR5trn.

The Deputy Crown Prince provided a breakdown of the government target of raising US$100bn in additional non-oil revenue annually by 2020. The bulk of this increase in non-oil revenue would come from the restructuring of subsidies which could generate US$30bn per year (4.9% of GDP), according to the Deputy Crown Prince. VAT implementation, a Green Card-like program and a plan to allow corporates to hire foreign workers in excess of their official quotas could bring in US$10bn (1.6% of GDP) a year by 2020, according to the Deputy Crown Prince.

Chart 14: US$100bn in additional non-oil revenue targeted by 2020

Source: Bloomberg

Chart 15: Government to focus on raising non-hydrocarbon revenue



Source: Haver, BofA Merrill Lynch Global Research

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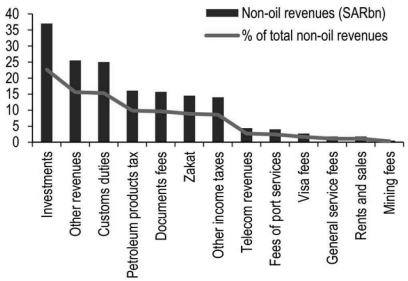
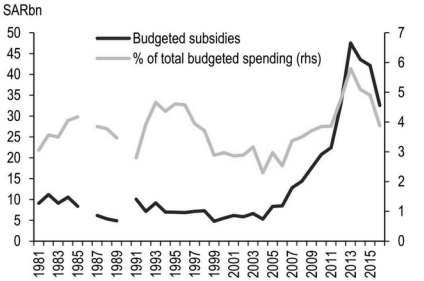
Chart 16: Breakdown of non-hydrocarbon fiscal revenues



Source: MoF, BofA Merrill Lynch Global Research. Data as of 2015.

Chart 17: Budgeted non-oil subsidies form a small portion of spending



Source: SAMA, MoF, Bank of America Merrill Lynch Global Research.

Further energy subsidy reform is likely

The figures announced by the Deputy Crown Prince regarding proceeds of subsidy reform suggests material changes over the next 3-4 years, with annual savings close to the landmark first round of administered price changes in late 2015. However, his suggestion that the changes could be accompanied by partially offsetting cash transfers to poor households suggests policy-making caution. We do not think such a redistributive system could be technically put in place in a short time span.

Recall that concurrently with the 2016 budget, a first round of energy subsidy reform saw sweeping energy, water and electricity administered price changes being instituted in late December. We estimated the natural gas price hike on petrochemical firms, domestic crude oil price hike as well as the combined gasoline and diesel price hike introduced could add US$2.2bn, US$2.0bn and US$3.8bn to central government revenues if fully passed to the budget (a combined 1.2% of GDP). Impact of continued similar policies on domestic prices would be a further 1.5-2ppt annual increase in headline inflation, and a gradual squeeze to household incomes (where gasoline, water and electricity likely represented c.1.5%, c0.4% and 1.6% respectively of consumer spending basket prior to the late December 2015 administered price adjustments).

Table 7: Administered energy price adjustments carried out in December 2015

Product	Price prior to Dec 2015	Current price	% change
Methane (US$/mn BTU)	0.75	1.25	66.7
Ethane (US$/mn BTU)	0.75	1.75	133.3
Arab light (US$/bbl)	4.24	6.35	49.8
Arab Heavy (US$/bbl)	2.67	4.4	64.8
Diesel (US$/bbl)	9.8	14 - 19.1	68.5
Heavy Fuel Oil (HFO) 380cst	2.08	3.8	82.7
Heavy Fuel Oil (HFO) 180cst	2.08	4.25	104.3
Propane (USD/metric ton)	-	-	-
Naphtha (USD/metric ton)	-	-	-
Butane (USD/metric ton)	-	-	-
Natural gasoline (USD/metric ton)	-	-	-
Kerosene (US$/bbl)		25.7	
95 octane gasoline (SAR/ltr)	0.6	0.9	50.0
91 octane gasoline (SAR/ltr)	0.45	0.75	66.7

Source: SPA, BofA Merrill Lynch Global Research. Propane, naphtha, butane and natural gasoline used to be: price using the following formula: Japanese Naphtha price less transportation from Saudi multiplied by 0.72. The formula now is differentiated by product and is as follows: Japanese price of the underlying product less transportation from Saudi multiplied by 0.8.

Fiscal consolidation plan looks challenging to fully achieve

The US$100bn target in additional non-oil revenue through 2020 appears difficult to reach and is likely to leave a sizeable financing gap based on the current proposals, in

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our view. This would thus imply that fiscal consolidation is likely to fall short of narrowing imbalances materially without a sustained oil price recovery.

The fees on excess foreign worker quotas and the green-card like program targeted proceeds are difficult to reach, in our view. We calculate that to raise US$10bn from a green-card like program, authorities will need to set the program fees at US$1,500 (in line with upper bound of similar programs elsewhere) and have all expatriate workers applying to enrol in the program. This appears an unrealistic target to meet, particularly as it is not clear how these proceeds would be recurrent yearly. As for the foreign worker quotas proceeds, we calculate that, based on private sector expatriate figures and the stated 85% overall compliance with Nitaqat sector quotas, that the fees would need to be set at a large cUS$10,500 per non-compliant worker to be consistent with the NTP target. The large fee amount would likely be a material disincentive to private sector corporates and a squeeze on their profits.

One of the obstacles to meeting the subsidy reform target is likely to be political in nature given the impact on inflation and household incomes. We calculate nevertheless that the target could be reached through a combination of a administered prices changes. We do not think there is major room to increase natural gas feedstock prices to petrochemical firms, given the NTP focus on the petrochemical sector as a source of future growth. We estimate raising natural gas prices to US spot levels in an oil price environment of US$50/bbl would bring in revenues to the central government of just US$2.5bn (0.4% of GDP) if fully passed to the budget. This is likely to suggest that the bulk of the future adjustments are likely to center on hikes to administered price adjustments for domestic crude oil sales, diesel and gasoline. Selling domestic crude at US$25/bbl rather than an average of US$5.4/bbl would bring in US$20.8bn in revenues. Gasoline and diesel prices could rise by the same percentage as in December 2015 to bring in additional revenues for a minimum inflation pick-up cost of 0.5ppt.

The most difficult part would be meeting the US$40bn in other non-oil revenues target, in our view. Given that the latter's breakdown was not provided, we have attempted to group several measures being studied (according to local press) to provide a tentative decomposition. Still, our analysis suggests the need for a further US$16.8-US$20.7bn in financing to meet the US$40bn target. Land tax proceeds of US$11bn in the first phase of implementation are the largest item, in our view. We calculate that a 20% sin tax on tobacco and sugary drinks would raise US$2.1bn (0.3% of GDP) at a 0.5ppt cost to inflation. A remittance tax being studied, according to local press, and could impose a tax of 6% gradually decline to 2% over a number of years. At the upper bound of the tax rate (6%), we calculate that the remittance tax would raise US$2.3bn (0.4% of GDP). We calculate that a 10% income tax on expatriates would raise at least between US$3.9-US$7.8bn (0.6-1.2% of GDP), depending on the assumed annual overall expatriate earnings. That being said, measures to tax expatriates could be detrimental to diversification and labor force prospects and were opposed to politically in the past.

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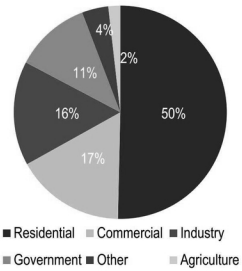
Table 8: Fiscal consolidation measures through 2020 leave undisclosed financing gap

Fiscal measure	Annual revenue raised (US$bn)	Annual revenue raised (% of GDP)	Impact on inflation (ppt)	Remark
Non-oil revenue measures	100	15.8	-	NTP target
Fees on excess foreign worker quotas	10	1.6	-	NTP target
Green-card like program	10	1.6	-	NTP target
VAT	10	1.6	5	NTP target
Subsidy reform	30	4.7		NTP target
Natural gas feedstock for petrochemicals	2.5	0.4	-	BofA ML assumption
Domestic crude	20.8	3.3	-	BofA ML assumption
Gasoline	1.4	0.2	0.5	BofA ML assumption
Diesel	1.9	0.3	-	BofA ML assumption
Other measures	40	6.3	-	NTP target
Land tax	11	1.7	-	BofA ML assumption
Remittance tax	2.3	0.4	-	BofA ML assumption
Income tax on expatriates	3.9-7.8	0.6-1.2	-	BofA ML assumption
Sin tax on tobacco	0.7	0.1	0.1	BofA ML assumption
Sin tax on sugary drinks	1.4	0.2	0.4	BofA ML assumption
Memo:				
Undisclosed revenue financing gap	16.8-20.7	2.7-3.3	-	BofA ML assumption
Cost savings	**Annual savings (US$bn)**	**Annual savings (% of GDP)**		
20% cut to on-budget non-oil subsidies	0.2-0.8	0.1-0.5	-	BofA ML assumption
5% cut to the wage bill	6.4	1.0	-	NTP target
Cost increases	**Annual cost increase (US$bn)**	**Annual cost increase (% of GDP)**		
NTP costs (US$71.5bn)	14.3	2.2		NTP target

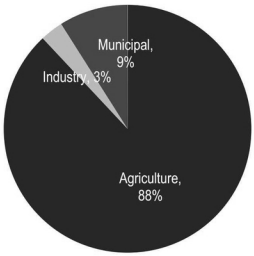
Source: National Transformation Plan, BofA Merrill Lynch Global Research

Chart 18: Breakdown of electricity consumption by sector



Source: SAMA, BofA Merrill Lynch Global Research. Data as of 2015.

Chart 19: Water consumption by sector



Source: UN, BofA Merrill Lynch Global Research. Data as of 2010.

Budgeted defence spending – up or down

Localization policies in the defence industry could help cut imports (total defence imports of US$9.8bn equivalent to US$1.5bn or 6% of total imports in 2015, according to consultancy IHS) and conserve Fx reserves, but we expect this to be a slow and gradual process. We think that large defense imports are typically amortized over a number of years. Defence spending is an important part of fiscal spending in Saudi Arabia, accounting for c30% of total budgeted spending. Defence spending in 2016 was budgeted at SAR213bn (US$56.9bn; 9.0% of GDP), down from SAR307bn (US$81.8bn; 12.7% of GDP) in 2015. Increased military and security projects in 2015 saw an additional overspend of SAR20bn last year. It is unclear to us if all of the regional military costs have been recognised on-balance sheet. A negotiated settlement to the Yemen conflict through the ongoing political negotiations in Kuwait could help contain security spending near-term.

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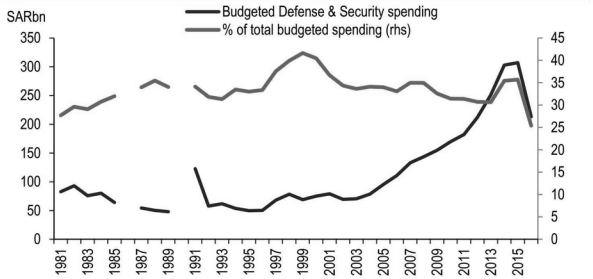
Chart 20: Budgeted spending – up or down?



Source: SAMA, Ministry of Finance, Bank of America Merrill Lynch Global Research.

Privatization comes back to the government's agenda

The consideration of a privatization program is not surprising at the current juncture, in our view. Recall that the Saudi privatization program was initially started in 1999 with the creation of the now-dissolved Supreme Economic Council, following the drop in oil prices in 1998. Small-scale privatizations took place in the early 2000s, and 2002 saw large privatization in the telecommunication sector and postal services.

Selling public sector stakes is one of the non-debt creating financing options for the government that would help minimize the direct drain on Fx reserves, encourage private sector development and improve services delivery. That being said, given the lack of non-oil taxation, this would only contribute to one-off financing flows alongside savings from a drop in budgetary allocations to the privatized entities, in our view.

The 2015 budgetary appropriations for public institutions totalled SAR163.7bn (US$43.7bn; 19.0% of total budgeted spending and 6.8% of GDP). We calculate that the public institutions related to the entities that appear to have been slated for privatization according to press reports account for budgetary appropriations of SAR124.8bn (US$33.3bn; 5.2% of GDP. This is likely to be the upper bound of fiscal savings possible under the privatization program. In our view, this is unlikely to be realized fully as it includes a large number of universities and because most timelines appear to center around 2020.

Table 9: Privatization / Public Private Partnerships (PPPs) planned

Entity	Date	Comment (press reports and Saudi Vision 2030/NTP, unless stated otherwise)
Airports	2016-2020	Targeted sale of 11 airport units by 2020
Saudi General Grains Organisation	1Q17	A financial advisor has been appointed
Saudi Aramco	by 2018	A stake of less than 5% could be sold
Stock exchange (Tadawul)	by 2018	A financial advisor has been appointed
Saudia Medical Services	-	Saudi Arabian Airlines appointed a financial adviser for the privatization of its unit Saudia Medical Services and had its Board of Directors restructured in June
Saudi Electricity (SEC)	by 2020	SEC's generation assets are likely to be split into four separate regional companies where minority stakes would be sold to major global utilities or sold in the public market
Saline Water Conversion Corporation (SWCC)	-	Investment partners are likely to be sought to buy a stake in production assets, with the holding company to be listed later
General Port Authority	by 2020	Commercialization program to be completed by 2020
Saudi Post	by 2020	Saudi Post to be turned into a holding company with six subsidiaries. The NTP aims to transform it to a commercially viable company with government subsidies (SAR2bn) to be phased out by 2020.
Education / schools	-	Official pronouncements have suggested this could be considered, but there does not appear to be concrete plans for now
Healthcare / hospitals	-	The 2030 vision suggests no privatisations in the near-term, in our view. Authorities are likely to look to improve management and quality of service before considering privatisation, in our view.
Road, railway and port projects	-	NTP suggests PPPs are planned with percentage in private sector contribution to development and operation to increase

Source: Press reports, Saudi Vision 2030, National Transformation Plan

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Table 10: Public institutions budget appropriations

	SARbn	US$bn	% of GDP
Universities	55.7	14.8	2.3
Saudi Arabian Airlines	28.5	7.6	1.2
Saline Water Conversion Corporation	15.6	4.2	0.6
General Authority of Civil Aviation (GACA)	15.5	4.1	0.6
Saudi Post Organization	3.2	0.8	0.1
Grain Silos and Flour Mills Organization	2.9	0.8	0.1
Saudi Ports Authority	1.8	0.5	0.1
Saudi Railways Organization	1.7	0.4	0.1
Other	38.9	10.4	1.6
Total	163.7	43.7	6.8
of which, public institutions in sectors that could be privatized	*124.8*	*33.3*	*5.2*

Source: SAMA, Ministry of Finance, Bank of America Merrill Lynch Global Research. Data as of 2015 budget.

Sales of PIF assets could help replenish fiscal reserves but not Fx reserves

Secondary sales of domestic assets could be a faster way than Initial Public Offerings (IPOs) and privatizations for the Ministry of Finance (MoF) to raise its fiscal reserves at SAMA, in our view. We look at this possibility to assess the potential for the MoF to use it as an option to support its fiscal reserves at SAMA and prevent a debt build-up in response to ongoing fiscal deficits.

If this were to take place, this could occur through holdings of the PIF rather than the pension funds who are large institutional investors in the domestic equity market, in our view. We calculate that the PIF could sell stakes worth around SAR200bn (US$53.6bn) domestically through liquidating existing minority stakes and selling down majority holdings while retaining control. If the PIF holdings are above 50%, we assume arbitrarily that the holding is strategic, and thus calculate the current value of the stake that the PIF (using the current stock price in the market) can sell down so it retains a controlling 51% ownership share. If the PIF holdings are below 50%, we arbitrarily assume that the holding is not strategic, and thus calculate the current value of the stake that the PIF holds (using the current stock price in the market) as we assume it could be fully liquidated.

The proceeds of sales domestically (without foreign participation) would increase central government deposits at SAMA, decrease other domestic liabilities of SAMA but keep Fx reserves unchanged. Because of the latter, because such large coordinated sales could weigh on the market and as the PIF is targeted to become the largest SWF by Saudi authorities, we doubt this is going to be a course policy-makers are likely to be considering in the near term.

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Table 11: Public Investment Fund listed domestic assets and their monetization potential in regards to replenishing fiscal reserves at SAMA

Entity	Sector	Current government stake (%)	Free-float (%)	Potential value of secondary offering if a government stake is sold, but with the government still retaining 51% control (US$bn)	Potential value of secondary offering if government's existing minority stake is liquidated (US$bn)
Saudi Basic Industries Corporation (SABIC)	Chemicals	PIF: 70.0%; GOSI: 5.7%	24.3%	12.3	0.0
Saudi Telecom (STC)	Telecom	PIF: 70.0%; GOSI: 7.0%; PPA: 6.77%	16.2%	6.5	0.0
Saudi Electricity (SEC)	Power	Government: 74.3%; Aramco: 6.9%	18.8%	5.1	0.0
Saudi Ground Services	Travel	Saudi Arabian Airline: 52.5%; National Aviation: 14.7%	30.0%	0.4	0.0
Saudi Real Estate Company	Real estate	PIF: 64.57%	35.5%	0.1	0.0
National Commercial Bank (NCB)	Banks	PIF: 44.3%; GOSI: 10%; PPA: 10.04%	35.7%	0.0	9.5
Maaden	Mining	PIF: 49.99%; GOSI: 7.98%; PPA: 7.45%	34.6%	0.0	5.9
Samba	Banks	PIF: 22.91%; GOSI: 11.76%; PPA: 15.04%	73.2%	0.0	2.4
Yanbu National Petrochemical Co (Yansab)	Chemicals	SABIC: 51%; GOSI: 11.92%	37.1%	0.0	2.2
Saudi Arabian Fertilizer Company (SAFCO)	Chemicals	SABIC: 42.99%; GOSI: 12.2%	44.8%	0.0	2.0
Riyadh Bank	Banks	PIF: 21.75%; GOSI: 16.72%; PPA: 9.18%	46.6%	0.0	1.9
Southern Province Cement	Cement	PIF: 37.43%; GOSI: 15.82%	46.8%	0.0	1.1
National shipping company	Transport	PIF: 22.55%	80.0%	0.0	0.9
Saudi Catering	Transport	General Airline Services KSA: 35.7%	39.8%	0.0	0.8
Kayan	Chemicals	SABIC: 35%	65.0%	0.0	0.6
Alinma Bank	Banks	PIF: 10%; GOSI: 5.10%; PPA: 10.71%	74.1%	0.0	0.5
Qassim cement	Cement	PIF: 23.35%; GOSI: 15.09%; PPA: 5.67%	79.2%	0.0	0.4
Yanbu cement	Cement	PIF: 10%; GOSI: 12.37%	68.5%	0.0	0.2
National Agriculture Development	Agriculture	PIF: 20%	85.1%	0.0	0.1
Saudi Fisheries	Agriculture	PIF: 39.99%	38.5%	0.0	0.1
Saudi Public Transport	Transport	PIF: 15.72%	100.0%	0.0	0.1
Eastern Province Cement	Cement	PIF: 10%; GOSI: 10.65%	89.4%	0.0	0.1
National Gas and Industrialization	Chemicals	PIF: 10.91%	88.0%	0.0	0.1
Saudi Ceramic	Consumer	PIF: 5.94%; GOSI: 16.19%	83.8%	0.0	0.0
Petro Rabigh	Chemicals	Aramco: 37.5%; Sumitomo: 37.5%	25.0%	0.0	0.0
Total				24.3	28.6

Source: Bloomberg, Bank of America Merrill Lynch Global Research. PIF = Public Investment Fund. GOSI = General Organization for Social Insurance. PPA = Public Pension Agency. Based on stock prices as of 28 June 2016.

Material fiscal consolidation would be necessary to narrow macro imbalances

There is no substitute for fiscal consolidation to maintain Fx policy unchanged. We map out below paths for several macro variables depending on fiscal policy and oil prices, with higher oil prices easing the adjustment requirement.

In a worst case scenario where US$25/bbl oil prices would persist for the next five years, sustainability of the Saudi Fx policy rests on material fiscal consolidation, which we believe is achievable based on the mix of revenue-raising and spending restraint plans likely or announced to date. This would require a total 5-year cumulative adjustment of SAR500bn (US$133bn; 20% of 2015 GDP or 4ppt of GDP annually) from 2016 onwards, which is close to what the NTP appears to be targeting in non-oil revenue measures (US$100bn, excluding NTP costs). We think 75% of the adjustment can take place through revenue-raising measures. The remainder of the adjustment would need to take place through capex cuts and is similar in size to the capex retrenchment of the 1980-90s. However, note that if one assumes that the 2015 budget deficit will be revised higher to 18.9% of GDP, this adds a need for a further 4ppt of GDP cumulative fiscal adjustment to maintain the same trajectory of Fx reserves.

An overhaul of fiscal policy will likely be required

In line with the 2016 budget announcement, we would expect tight budgets to be passed. We expect a VAT with 5% yield to be implemented in 2018, alongside further administered price adjustments for energy, water and electricity. Implementation of the land tax is likely, but it is unclear whether the proceeds will be ring-fenced to be used solely for housing projects. Using solely the recurring existing proceeds of the December administered price adjustments and a VAT introduction, we still see a need for further fiscal restraint in the order of 1ppt of non-oil GDP annually. The latter would

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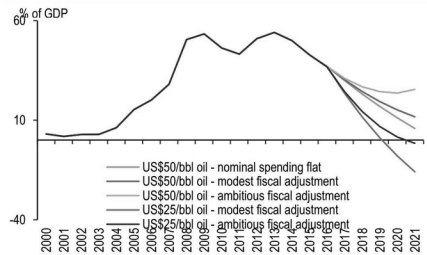
be equivalent to a SAR100bn cumulative spending cut, which we believe can be accommodated from capex retrenchment. On the basis of the above, fiscal consolidation would likely drive real GDP growth lower to an average of just around 1% of GDP. This estimate is based on a ST GCC fiscal multiplier of 0.2 for real spending to real non-oil GDP, in line with academic literature.

Fx policy stays the course; NTP blurs medium-term incentives

We do not believe Deputy Crown Prince Mohammed bin Salman is considering Fx reform in the near-term. We have expressed here our view that the Fx peg would hold as fiscal policy undergoes a sizeable multi-year adjustment. In a bearish scenario for oil prices, the NTP is unlikely to be implemented as deep budget cuts are likely to be required to sustain the Fx policy. We believe an oil price of at least US$50/bbl is broadly consistent with full and timely NTP implementation, but fiscal policy still needs to be disciplined. If fiscal non-oil revenue targets are missed, a higher oil price is likely to be needed.

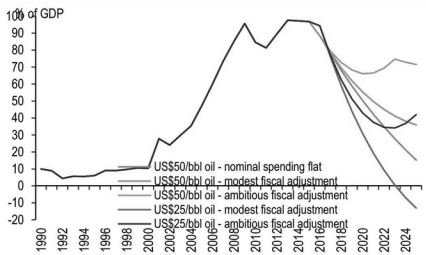
However, if the NTP is successful in diversifying the economy, it will make the costs of running an overvalued exchange rate more prohibitive, particularly as the external accounts are likely to become more responsive to an Fx shock. It also introduces a pro-growth bias for policy-makers in charge of diversifying the economy, which may conflict with the implementation of unpopular fiscal reforms or the depth of fiscal consolidation needed at weak levels of oil prices. The NTP diversification initiatives may suffer from a timing mismatch when it comes to net external receipts generated. This is because the sectors that would generate Fx receipts (non-oil exports, religious tourism) or localization policies are likely to be slow to ramp-up, while Fx demand in the economy is likely to be supported (rather than deflated) by government diversification policies. Last, the desire to build a large SWF may suggest a desire to conserve Fx reserves.

Chart 21: Illustrative paths of Saudi government deposits at SAMA



Source: , Haver, BofA Merrill Lynch Global Research estimates

Chart 22: Illustrative paths of SAMA foreign assets



Source: Haver, BofA Merrill Lynch Global Research estimates

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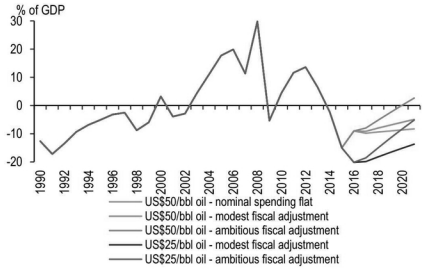
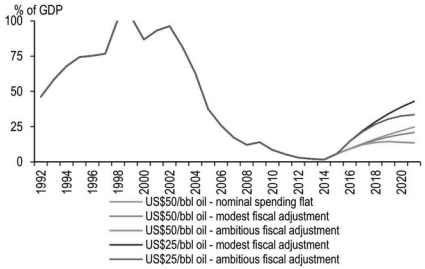
Chart 23: Illustrative paths of Saudi fiscal balance



Source: Haver, BofA Merrill Lynch Global Research estimates

Chart 24: Illustrative paths of Saudi government debt



Source: Haver, BofA Merrill Lynch Global Research estimates

Consumer to face mixed trends

Labour policies are likely to remain a major focus for the Saudi government. Low oil prices have dented the government's direct ability to support the consumer compared to the boom years. Furthermore, negative to flat public sector wage growth is likely to dampen income and consumption trends, although Specialized Credit Institutions (SCIs) could alleviate tightening banking sector household lending standards.

The NPT suggests a focus on boosting female employment as well as increasing the cost of foreign labor relative to national labor. The latter implies a negative impact on corporate margins and profits, in the event higher labor costs are not reflected in higher consumer prices and inflation). The negative near-term cost and efficiency implications of continued labour market reforms are mitigated by the fact that eventual increase in private sector employment of higher-paid Saudi labour should prove supportive for consumption trends once the dust settles.

The NTP targets increasing the cost of employment of Saudis compared to expatriates from 400 to 280. We calculate that the ratio of private sector wages of Saudis compared to non-Saudis stood at 3.64 and 1.29 for males and females respectively in 2015. The NTP target is thus akin to increasing non-Saudi private sector wages by 43% over the period to 2020, a CAGR increase of 7.4%. This would squeeze corporate profits, lead to inflationary pressures in the economy, and lead to annual additional Fx outflows through remittances of US$2.8bn (0.4% of GDP). As such, it is more likely that the employment cost of non-Saudis is likely to be increased through measures such as fees for government services, taxes and levies. It is unclear that the NTP target can be met solely through this route, but it would avoid additional Fx outflows despite still having a negative impact on corporate margins and inflation, in our view.

The Nitaqat Saudization program is likely to be extended in the near-future through the forthcoming launch of the "balanced Nitaqat" initiative. While employment quotas are likely to be tightened, they will also take into account wage levels, job quality and women employment ratios, according to local press. A likely target is likely to be increased job creation for Saudis in the retail sector through higher quotas, in our view.

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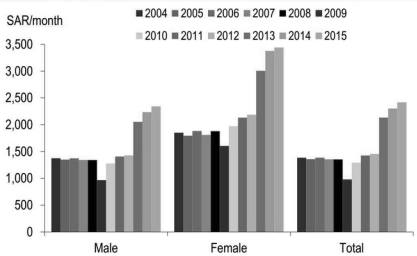
Table 12: Selected drivers of Saudi consumer

	Direction	Comment
Oil prices	Volatile	Indirect impact through economic activity and confidence
Population growth	Decreasing	Direct impact through lower number of expatriates and national birth rate
Public sector wage growth	Flat to contracting	Freeze in government wage bill
Private sector wage growth	Flat to minor increase	Some sectors to contract (construction), others resilient (retail, staples)
Saudi private sector male employment	Mixed	Saudization helps, but economic slowdown and supply-side factors impact negatively
Saudi private sector female employment	Increasing	NTP aims to increase it through several measures
Consumer leverage	Decreasing	Banking sector liquidity and lending standards are tightening
Real estate finance	Increasing	NTP measures are supportive in this area
Specialized Credit Institutions (SCIs)	Flat	SCIs can continue to support the economy
Saudization	Increasing	Negative impact short-term, positive impact medium-term
Subsidies	Decreasing	Timing and breadth unclear as of yet
Other fiscal consolidation measures (VAT, etc)	Likely forthcoming	Direct and indirect negative impact on consumer

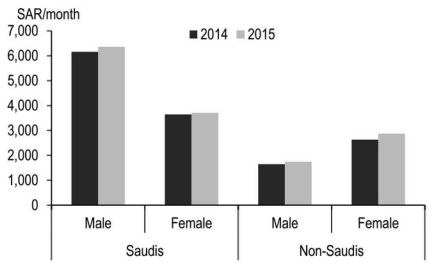
Source: BofA Merrill Lynch Global Research

Chart 25: Private sector average monthly wages are increasing



Source: SAMA, BofA ML Global Research. SAMA wage data coverage appears incomplete.

Chart 26: Wedge between Saudi and non-Saudi private sector salaries



Source: General Organization for Social Insurance (GOSI), BofA ML Global Research.

Banks and contractors will require supportive policies to realize NTP benefits

The banking sector is targeted to benefit from the NTP initiatives through greater disintermediation (SMEs, real estate financing, non-oil export financing) and greater household savings. However, domestic liquidity is likely to remain structurally tight, in our view. The NTP targeted increase in non-oil fiscal revenue is likely to tighten domestic liquidity, all else being equal, as it would have the effect of extracting resources from the non-hydrocarbon private sector (as opposed to government domestic spending that injects liquidity).

Linked to liquidity trends and banking sector asset quality, the issue of government arrears to contractors is likely to take centre stage, in our view. Resolving this is likely to be required if the capex projects under the NTP are to be executed on a timely fashion, in our view. We think the government's proposal to issue "I Owe You' notes (IOUs) could be a step in this direction.

Government looks to issue IOUs

According to the press, the Saudi government has paid contractors some cash on its arrears, and is considering to issue "I Owe You' notes (IOUs) to them. Contractors would receive these notes to cover their outstanding dues, which they could hold until maturity or sell on to banks. The government has been highlighting it wanted to settle the contractor sector dues, and recently a high-profile domestic contractor has made mass redundancies. In the previous downturn in the 1980s, arrears to domestic contractors were also likely to have been accumulated. We highlighted that the fiscal deficit was likely under-reported last year. Also, construction was one of the fastest growing sector last year both in terms of domestic activity and of domestic credit.

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Government arrears to contractors could be significant
We estimate the range of unpaid capex for 2015 to be SAR23bn-SAR100bn (US$6bn-US$27bn or 1-4.3% of 2015 GDP). At the very minimum, unpaid capex could be around SAR23bn. This is the amount of additional loans taken out by construction contractors over 2015 compared to 2014. Total construction loans were SAR106bn in 2015 versus SAR83bn in 2014. Contractors likely did not go to obtain alternative bank funding for the same amount as the delayed payments from the government, suggesting delayed payments should be larger than SAR23bn, in our view.

By the same token, the 2015 budget outturns imply capex was down by 45% to SAR205bn versus 2014 levels of SAR370bn. This is of course unlikely as construction grew by 5% in real terms in 2015. Correcting the 2015 budget by the likely underreporting (an additional SAR100bn in spending, assuming it was all capex-related), then capex spending was likely down by SAR65bn (17%) in 2015. This would be in line with the c15%yoy drop in construction awards as reported by MEED.

In comparison, government overdues in the healthcare sector are much smaller. Based on the disclosures of two listed healthcare groups, we estimate the growth of government receivables owed to them alone is SAR0.4bn. We estimate the total sector government overdues to private healthcare operators could be 2-3 times this level.

IOUs to serve multiple purposes
IOUs could support simultaneously the multiple needs of the government, domestic banks and contractors, in our view. The government will be able to conserve fiscal reserves and restructure the maturity of its outstanding dues. Domestic banks would substitute corporate credit risk with sovereign risk and improve asset quality, while contractors could improve their liquidity and working capital position by cashing in early on the IOUs. We believe most of the contractors impacted could be domestic ones, and we presume these IOCs would be issued in domestic currency. Furthermore, to the extent these IOUs are structured as tradable instruments, this could better distribute risk in the financial sector to those agents more capable or willing to hold it.

Domestic liquidity could be eased, but Fx outflows may not subside
The impact of IOUs on domestic liquidity will likely depend on the issuance mechanism, of which we have little visibility for now, though this could likely ease domestic liquidity. We would however expect subsequent Fx reserves losses due to an increase in demand for Fx consequent to the liquidity injections (a 50% leakage would for instance lead to US$13.5bn loss in Fx reserves at the high-end of the estimated arrears range).

One possibility for the mechanism would be for banks to extend more secured credit to contractors using the IOUs as collateral. In this case, domestic liquidity is likely to remain tight as the banking sector balance sheet would stay stretched. Another, perhaps more likely, option would be for banks to accept IOUs as deposits. Contractors would then be able to transfer IOUs to their trade creditors and withdraw cash regularly, with the total amount being likely a portion of the face value of the IOUs. Banks would hold new government instruments on the asset side of their balance sheet. This mechanism could also be structured as a simple sale of the IOUs to domestic banks (with a haircut), which domestic banks would accommodate through equivalent changes on the asset side of their balance sheet, without the creation of additional liabilities.

In the latter option, to avoid straining the banking sector liquidity, the deposits withdrawal or in effect the increased money in circulation would likely require monetary accommodation from SAMA, in our view. We believe this could take the form of liquidity injection, possibly through repo operations for the IOUs. Although unconventional, this

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possible source of easing of domestic liquidity would still be consistent with Article 6 Saudi Arabia's Currency Law which imposes a 100% currency backing by Fx reserves, such that that currency issued cannot exceed foreign reserve assets. The full cover requirement would still be in force as reserve money currently represents just 14% of foreign reserve assets, down from c100% throughout the period 1996-2000.

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Lessons in diversification

There are only few examples of countries that successfully managed diversification away from primary dependence. The examples of Malaysia and Norway suggest that a sound institutional framework, robust fiscal framework, supportive public sector industrial policies, appropriate business climate and human capital are important factors in enabling successful diversification away from the oil sector. A backdrop of low oil prices exacerbates diversification challenges but also provides impetus for change.

Saudi comprehensive reforms follow standard template to shift gears

The Saudi NTP broadly follows the generally accepted template of comprehensive macro- and micro- reforms needed to diversify beyond the hydrocarbon sector, in our view. The literature suggests successful diversification entails ideally a combination of three types of innovations: processes, products and organizations. Enhancement in processes would enhance productivity, new products would support emergence of new sectoral growth drivers, and improved micro- and macro-governance would help sustain production gains. The key to furthering the development path would be to move from an initial labour- and capital-intensive phase towards a phase focused on increasing productivity growth through higher value-added sectors.

This will require the retention of white-collar workers, steady progress on institution-building, an increase non-hydrocarbon FDI, horizontal and vertical integration, a broader manufacturing base including at first through sectors with competitive advantage (downstream or energy-intensive ones), greater integration into the global value chain through enhanced trade relations, as well as education and business climate reform to overcome structural rigidities, in our view.

Medium-term diversification may require Fx reform

As diversification progresses, the case for increased Fx flexibility and making space for autonomous monetary policy conduct is likely to gradually take shape. Presumably, such a move would require putting in place a supportive institutional structure which is currently broadly lacking. It would also await improvements in productivity growth and the development of competitive local industries to minimize a potential Dutch disease effect on infant or other sectors. A fairly valued real effective exchange rate (REER) would support efficient allocation of production factors across sectors and improve competitiveness of the tradable goods sector.

Malaysia case study highlights the role of supportive public sector

Malaysia's diversification away from primary commodities relied on a series of National Industrial Policies and Industrial Master Plans to promote the manufacturing sector. Focus was given to sectors with high export potential, and efforts were taken to create linkages with other sectors and to deepen interconnection with other industries. Growth strategies also aimed to develop local technological capabilities and clusters of industrial development, similar to the localization and industrial strategies spearheaded by the Saudi National Transformation Plan.

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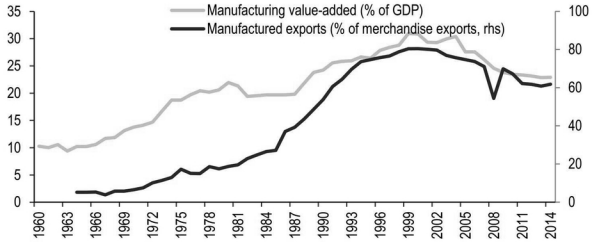
Chart 27: The launch of government industrial policies in the 1980s helped Malaysia diversify



Source: Haver, BofA Merrill Lynch Global Research

Norway case study suggests institutions are paramount

While it is perilous to extend lessons that could overemphasize idiosyncracies, the case of Norway highlights, if anything, the importance of sound institutions and macro management when it comes to broader economic diversification. The case of Norway has relevance for the Gulf Cooperation Council countries (GCC), including Saudi Arabia, especially since oil discovery (late 1960s) and oil production (1970s) timelines were not that sensibly different from the GCC.

That being said, outcomes were widely different as well as the starting point since Norway was already a developed country with mature social, economic and political institutions at the time of the discovery of oil. This allowed a distinction between the management and ownership of natural resources uncommon in the GCC and several other resource-based economies, in our view.

Four ways in which the supply-side matters for economic diversification

We believe that there are four lessons to learn from Norway's outperformance:

1) The importance of human capital

Norway's priorities from early on were to build human capacity, investing in education, increasing labor force participation and supporting productivity growth.

2) Prudent conduct of fiscal policy

Current Norwegian oil revenue management puts considerable emphasis on stabilizing the economy and facilitating a gradual phase-in of oil revenues over time (which crowds out trophy projects and put onus on achieving productivity gains in the non-oil sector). Following the 1970-80s boom-bust sequence and expansion of the welfare state, Norway established in 1991 a Government Petroleum Fund to receive and invest oil revenue (it received its first net transfer in 1996). The fiscal rule adopted in 2001 targets a central government structural non-oil budget deficit equal to 4% of GPF assets (the latter assumed to be its estimated long-run real rate of return). That being said, Saudi Arabia's infrastructure requirements could have prevented adapting this part of Norway's model for long, in our view.

3) Institutional experience

Norway's development has been characterized by continuous development and integration of resource-based export-oriented industries, some of which were active since 1950. While Norway is the world's third largest exporter of natural gas and the sixth largest of crude oil, it is also the second largest exporter of seafood, possesses the fourth largest shipping fleet, is the sixth largest exporter of aluminium and the first exporter of sub-sea technology products and services.

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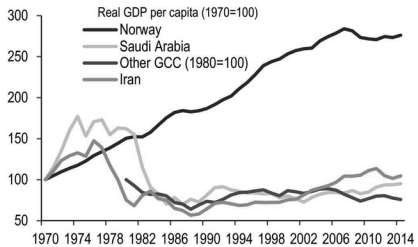
4) Industrial policy

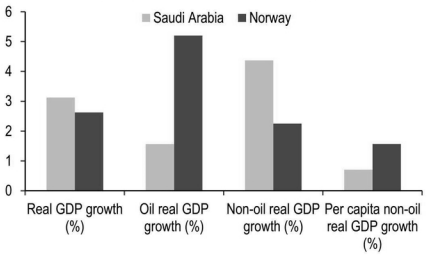
Norway's active use and introduction of a national industrial strategy has helped shelter infant industries and create linkages between the natural resource-based industries and other sectors of the economy. For two decades (1972-1994), preference was given in a transparent fashion to local content in procurement to help build supply industries, and provisions were set in for international firms to train nationals, use domestic service industries and cooperate in R&D with local institutions. Though Norway pre-dates the GCC in this development, the region shares in many ways some of these policies, leading to the emergence of national champions. The main difference appears to relate to the scope, extent and degree of innovation involved in offshoot industries at this stage, in our view.

Chart 28: Norway real GDP per capita growth outpaced GCC over the past decades



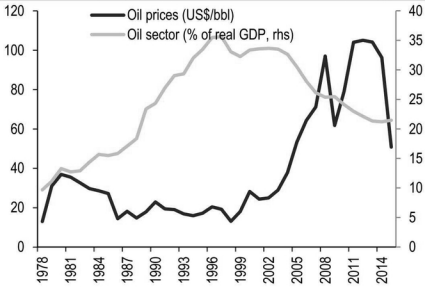
Source: Haver, BofA Merrill Lynch Global Research

Chart 29: Norway outperforms Saudi indicators on a per capita basis



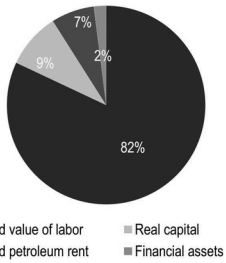
Source: Haver, BofA Merrill Lynch Global Research. Data represents averages over 1979-2014.

Chart 30: Norway's hydrocarbon sector share in real GDP has dropped



Source: Haver, BofA Merrill Lynch Global Research

Chart 31: Human capital is Norway's most important resource



Source: Norway Ministry of Finance, BofA Merrill Lynch Global Research

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Eurobond premium required for fiscal slippage risk

We expect large and regular sovereign eurobond issuance going forward to support FX reserves and domestic liquidity but weigh on regional bond spreads if risk appetite does not hold up or fiscal slips. EMBIG index inclusion is unlikely, in our view. Saudi Arabia CDS premium to Qatar and likely larger issuance size suggests Saudi External Debt (EXD) is likely to be issued at a premium to Qatar.

Saudi Arabia international bond issuance latest in wave of Gulf supply

Local press suggests that Saudi Arabia is gearing up for a large international bond issuance program (US$10-15bn issuance target this year), which, if confirmed (the government neither confirmed nor denied , should add to the sizeable sovereign bond supply pipeline this year. So far, we have seen US$17.1bn in gross and net supply from the Gulf Cooperation Council (GCC) countries. Assuming Saudi Arabia issues US$15bn and accounting for planned issuance from Dubai and Bahrain and excluding Kuwait, the rest of this year should see a further US$16.5bn in gross issuance and US$16.1bn in net issuance. This would bring the total gross and net GCC sovereign bond issuance to US$33.6bn and US$33.2bn this year respectively.

Seminal potential bond issuance has multi-pronged implications

If confirmed, this could be a seminal event and mark the first time for the Saudi government to issue external bonds. It would allow for participation of foreign investors as domestic debt is being sold to Saudi banks and funds. External issuance should diversify funding sources, lock in still low interest rates, support SAMA's Fx reserves and support domestic liquidity; the latter two macro variables have weakened this year. External issuance would also imply the presence of an underlying asset that could theoretically trigger CDS contracts, as opposed to the current situation.

Investment grade status to be retained despite likely further rating cuts

A prolonged oil price downturn is likely to continue to put downward pressure on Saudi Arabia's credit rating in the medium-term. On average, the GCC has benefited from three notch rating upgrades over the period 2002-10 prior to the start of the Arab Spring. Saudi Arabia was upgraded six times, from Baa3 to Aa3, by Moody's over the period starting from 1999, while it was upgraded two and three notches by S&P and Fitch over the period starting from 2003/2004 respectively. Moody's has thus in the past preserved Saudi Arabia's investment grade rating at the bottom of the cycle, as government debt to GDP stood at 103% of GDP and SAMA's foreign assets at US$17bn (10% of GDP) in 1999.

EMBIG Index inclusion is unlikely

EMBIG index inclusion is unlikely, in our view. Estimated 2013 (US$25,140) and three-year rolling GNI per capita (US$23,090) data likely suggests Saudi Arabia does not meet EMBIG income index inclusion criteria, in our view. Saudi Arabia would however likely be eligible for Barclays EM Hard Currency Aggregate Index, based on its IMF classification as a non-advanced country (noting that the index provider has moved away from solely using rating for EM country classification). This suggests that Saudi policy-makers need to articulate a comprehensive, timely and credible medium-term fiscal policy to facilitate wide take-up from domestic, regional and international investors, in our view.

Pricing matters

Saudi Arabia CDS premium to Qatar, relative credit metrics and likely larger planned issuance size suggests Saudi EXD is likely to be issued at a premium to Qatar, in our view. The closest regional peers to Saudi Arabia (A1/A-/AA-) are likely Qatar (Aa2/AA/AA) and Abu Dhabi (Aa2/AA/AA). Qatar's existing external debt curve makes it a potentially

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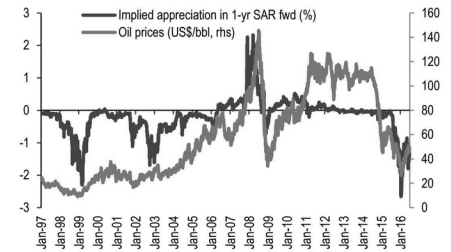
useful and relevant pricing benchmark in this regard, in our view. The Qatar 10-year sovereign bond currently trades at yields of 3.0%. However, Saudi CDS has been trading c65bps wider of Qatari CDS, which would suggest a 10-year Saudi bond yield of c3.65%. Current CDS spread levels suggest potential for some notch downgrades from Saudi Arabia's current rating, as the market prices in issuance risk, volatile oil prices, hedging flows relative to the USD peg and the banking sector off-balance sheet wrong-way exposure risk.

Saudi forwards, rates and CDS remain under pressure

Domestic rates are under pressure with the 5y IRS spread over US at historically elevated levels due to structurally tighter liquidity. Budget consolidation could help take some of the pressure off as it would imply lower debt issuance needs. However, it would also imply lower deposit formation in domestic banks as fiscal retrenchment will impact private sector economic activity. Greater risk premium, issuance pressures and tighter liquidity will also keep CDS spreads elevated until oil recovers.

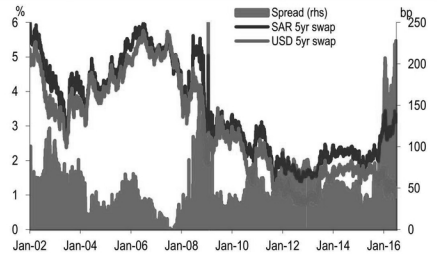
Hedging against SAR devaluation risks remains strategically attractive given the risk-reward ratio. Data suggest a strained backdrop for external and domestic liquidity reflecting the combination of private sector dollarization, possible capital outflows, weakening deposit formation and the move higher in interbank rates. However, SAMA has already intervened through macro-prudential tools and may do so again if needed.

Chart 32: Market remains nervous on Saudi Arabia



Source: Bloomberg BofA Merrill Lynch Global Research.

Chart 33: A pronounced increase in SAR swap spreads vs USD



Source: Bloomberg BofA Merrill Lynch Global Research.

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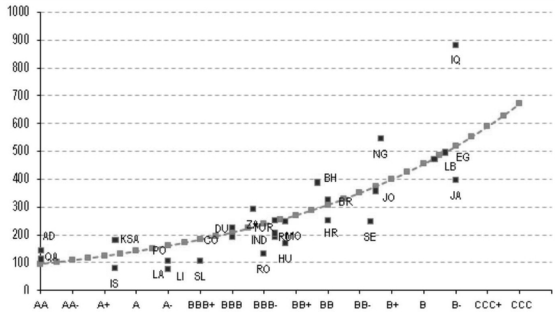
Exhibit 2: Saudi credit risk prices in rating downgrades



Source: Bloomberg BofA Merrill Lynch Global Research.

Commodities: NTP adds to medium-term oil market tightness

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The Saudi National Transformation Plan (NTP) suggestion that production capacity is to be maintained at the current level until 2020 reinforces our conviction of medium-term oil market tightness. We continue to see a call on OPEC of 4.1mn bpd in the next five years to "balance the market", and see oil prices of US$55-75/bbl over 2016-2020. Although the NTP incorporates a target of boosting domestic gas production by 50% to 18 bcf/d by 2020 which could crowd out oil demand, we expect Saudi Arabia's ability to switch to reduce oil burn in power generation to 2020 to be quite limited, in our view.

We see oil averaging US$55-75/bbl over 2016-2020

Real Brent prices are at one of the lowest levels in decades, and will likely encourage very strong demand growth ahead, while we see supply falling across non-cartelized producers. As such, we see global light sweet crude oil averaging US$55 to US$75/bbl over the 2016-2020 period, depending on how much incremental production OPEC can and will supply over the next five years. We think it likely that Saudi will dig into its untested spare capacity to go for increased market share, though uncertainty over how much Saudi can and will produce remains. We also remain concerned about output sustainability among weaker cartel members given the rapid credit profile deterioration.

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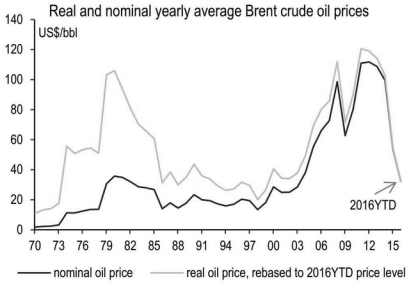
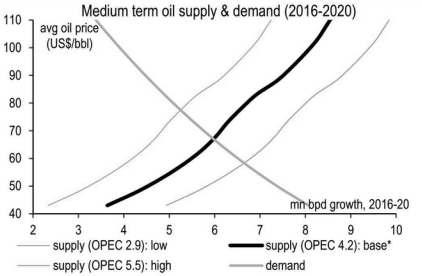
Chart 34: Real Brent prices are at one of the lowest levels in decades, and will likely encourage very strong demand growth ahead



Source: BP, Bloomberg, BofA Merrill Lynch Commodities Research

Chart 35: We see global light sweet crude oil averaging US$55 to US$75/bbl over the 2016-2020 period

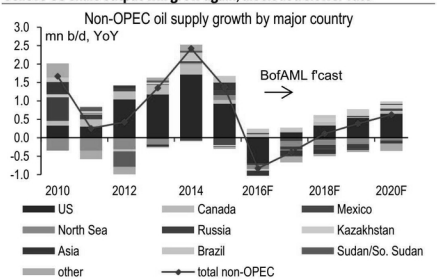


Source: IEA, BofA Merrill Lynch Commodities Research
*4.2 mn b/d OPEC supply: Saudi: 1.3 mn b/d; Iraq: 0.8 mn b/d; other OPEC crude: 1.7 mn b/d; 0.4 mn b/d OPEC NGLs.

Non-OPEC production will not reach 2015 levels before 2020 at the earliest...

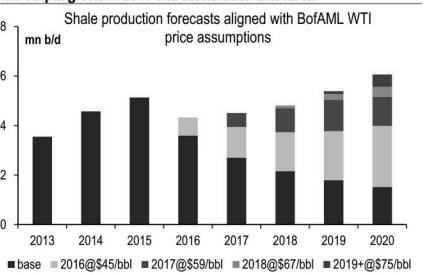
Non-OPEC producers have massively reduced capex spending, down US$290bn or 42% from 2014 to 2016, in response to the low price environment. Should capex start to increase again in 2017, the effect on non-OPEC non-shale production is unlikely to be felt before 2020 at the earliest. Most of the decline in the short term comes from non-conventional output in the US, as shale is very price sensitive within a 12-month horizon. With Brent prices set to increase from US$46/bbl this year to US$80/bbl in 2020 in our base case, we believe US shale production will grow again, albeit at a slower rate than in the past four years. Total non-OPEC supply is set to drop to 56.4mn bpd in 2017 before rebounding to 57.5 mn bpd in 2020, a similar level as in 2015.

Chart 36: With Brent prices set to increase to US$80/bbl in 2020, we believe US shale output will grow again, albeit at a slower rate



Source: IEA, BofA Merrill Lynch Commodities Research

Chart 37: Linking this with our 5-year price deck suggests marginal US shale output grows in 2017 and acceleration thereafter



Source: EIA, BofA Merrill Lynch Commodities Research

4.1mn bpd needs to be added by OPEC by 2020, namely Saudi, Iran and Iraq

The US is the only country able to ramp up production among non-cartelized players by 2020, so OPEC has to come to the rescue to provide the required incremental supplies. We estimated that demand will grow by 5.9mn bpd in 2015-20. With the market oversupply of 1.8mn bpd in 2015, OPEC needs to increase production by 4.1mn bpd in the next five years to "balance the market". Saudi Arabia could make up for half of this given its c2mn bpd of spare capacity, and we believe it intends to at least increase its market share. We would expect other OPEC countries to expand their capacity in the

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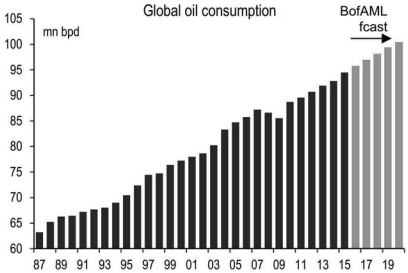
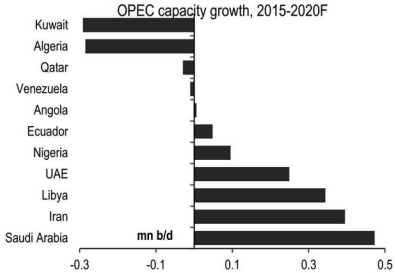
next five years, namely Iran and the UAE. As for Libya, the current turmoil needs to come to an end, while the scale of any Iraqi long-term output increase remains the biggest uncertainty.

Chart 38: We estimated that demand will grow by 5.9mn bpd in 2015-20



Source: IEA, BofA Merrill Lynch Commodities Research

Chart 39: Other than Saudi Arabia, some OPEC countries will also expand their capacity in the next five years, namely Iran the UAE

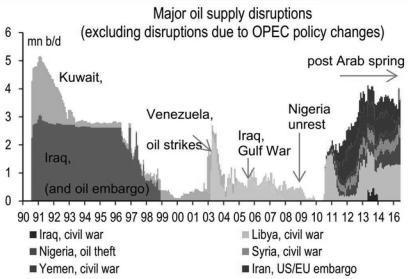


Source: IEA, BofA Merrill Lynch Commodities Research

Saudi plans to keep capacity flat add to medium term tightness

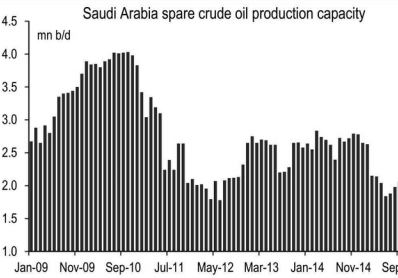
Saudi Arabia has 12.5mn bpd of crude production capacity, according to the government, and the country suggested within the NTP that it plans to maintain capacity at the current level to 2020. Saudi Arabia is the only material holder of spare crude oil production capacity around the world. Spare capacity currently sits at c2mn bpd, which is one of the lowest levels ever. Even if Saudi Arabia did start investing today, it would take a number of years to be completed and would unlikely be ready before 2020 in any case. Hence, as Saudi ramps up production over the medium-term by digging into its spare capacity, the risk premium in the oil market will rise as the market becomes increasingly less able to handle future supply disruptions.

Chart 40: The supply side in oil faces a lot of disruptions linked to geopolitics and broad economic mismanagement



Source: IEA, BofA Merrill Lynch Commodities Research

Chart 41: Saudi Arabia has 12.5mn bpd of crude production capacity, and currently is c2.0 of spare capacity over current production



Source: IEA, BofA ML Commodities Research. IEA estimates Saudi production capacity at 12.2mn bpd

If Saudi gas production gets off the ground, it could crowd out oil demand...

The Saudi NTP plans to grow domestic gas production by 50% to 18 bcf/d by 2020, and to use most of this gas to meet a 30% rise in domestic power demand and moreover boost gas' share in power generation to 70%, up from 50% currently. This implies that oil burned for power generation could drop by 30% or 300 thousand bpd by 2020, most of which would likely be crude which is more valuable in the export market than the

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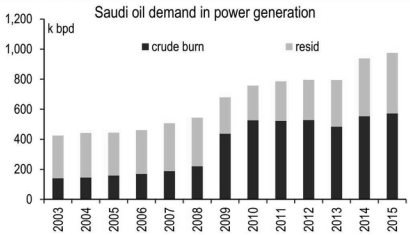
residual fuel oil burned. Saudi Arabia has the world's 4th largest gas reserves, yet reaching the 5.8 bcf/d production growth target by 2020 is not that straight forward.

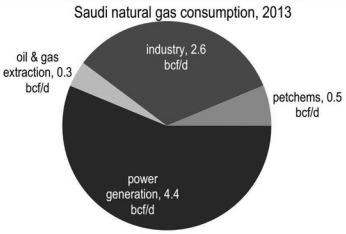
...though boosting gas production to the NTP target poses significant challenges
The new Wasit project, which is due to come online in 2016 and ramp up to 2.5 bcf/d by 2020, meets about 40% of the gas production growth target. Other than that, Saudi Arabia is focusing on getting unconventional production off the ground to meet the remaining 3.3 bcf/d of the production growth target. The timing, cost and commercial feasibly of which this unconventional gas is highly uncertain. The 2.5 bcf/d from the Wasit project is about the amount of gas that would be needed to meet incremental power demand and displace 300 thousand bpd of crude burn, assuming gas demand does not grow in other sectors, which is unlikely. Hence, it is likely that Saudi's ability to switch significantly to reduce oil burn in power generation to 2020 will be quite limited, explaining the new openness to consider gas imports, in our view.

Chart 42: Oil burned for power generation could drop by 30% or 300 thousand bpd by 2020, most of which would likely be crude



Source: IEA, BofA Merrill Lynch Commodities Research

Chart 43: Other sectors like petrochemicals and industry will see their gas demand grow as well



Source: IEA, BofA Merrill Lynch Commodities Research

Equity Strategy: more clarity required, but investible themes emerging

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More clarity required, but high level benefits becoming evident
The recent National Transformation Program (NTP) document provided a much awaited articulated roadmap through 2020 of how the government is seeking to achieve its highly ambitious Vision. However, we believe significantly more detail is still required before the market can make more concrete conclusions on the key winners and losers from the program as well as quantify the impact it could have on corporate earnings (both positive and negative).

Whilst at this juncture it is difficult to quantify the size of the NTP opportunity for individual companies, we feel more confident in highlighting the sectors that we see could benefit from Saudi Arabia ambitious plans. We have detailed the sectors that we see as likely benefiting most in the table below. We also highlight the sectors which could face the most negative impact from the roll out of the NTP.

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Table 13: Summary of key sectors likely benefiting from and impacted by the National Transformation Program

Sectors likely benefiting from NTP	Rationale
Petrochemicals	With US$ 11bn being allocated to project development, downstream chemicals second largest focus of NTP; significant increase in natural gas availability (indigenous and imported); expansion opportunities
Healthcare	Volume growth opportunities for private healthcare providers (management contracts); private health insurance growing; participation in privatisations; significant increase in local pharmaceutical production
Insurance (healthcare)	Private insurance coverage to increase to 31mn from 10.5mn currently; rising availability of private healthcare facilities
Real estate	Higher home ownership targeted; improved access to financing/housing subsidies to both developers and buyers; volumes set to expand as NTP targets higher real estate sector growth; increased opportunities for private sector investment
Consumer staples	Demand growth from religious tourists; formalisation and Saudisation of retail sector; growth in locally produced poultry sales; longer-term private sector job creation
Telecom	Government spending US$2bn to enhance FTTH and Mobile networks; focus on increasing internet usage; religious tourism will boost demand
Metals and mining	Provision of new mining licenses; potential investment opportunities for international mining companies
Defence	Increased localization will cut imports, develop local industrial capabilities and create jobs
Sectors likely negatively impacted by NTP	**Rationale**
Consumer discretionary	Near-term squeeze on consumer disposable income and sentiment; increased competition as foreign entities given 100% ownership entitlement; development of Saudi postal system possibly a precursor to online shopping increase
Petrochemicals	Potential reduction in feedstock subsidies; potential for increased competition from international companies
Real estate	Land tax on white land could impact cost base and prices in urban areas; higher competition from new entrants
All sectors	Rising costs on reduced subsidies (particularly water and energy); higher wage costs; increased financing burden on private sector as government partially shoulders NTP costs

Source: National Transformation Program, BofA Merrill Lynch Global Research,

Six key investible themes from the NTP are emerging

Using this frame work we believe a number of investible themes are emerging including:

1. **Ambitious plans to grow religious tourism:** with Hajj visitors set to increase from 1.5mn to 2.5mn and Foreign Umrah Pilgrims from 6mn to 15mn per annum, we see significant potential for the travel & tourism, transport sectors, consumer discretionary and telecom services sectors to benefit.

2. **Down trading as pressure mounts on the consumer:** With the NTP looking to reduce subsidies on energy (including transport fuels) and water, we see pressure on the disposable income of Saudi consumers rising in the short- to medium-term (although in the longer term, we expect higher employment levels, growing home ownership and accelerating growth to offset these factors). These issues could be further augmented by a slowdown in public sector wage growth and growth in the proportion of residents employed by the private sector,

   In reflection, we believe that the consumer will likely become more value conscious in the near- to medium-term as stress on consumer discretionary spend mounts. As such, we continue to prefer the consumer staples and the grocery retailers in this environment. We also believe the grocery retailers will benefit from the government's focus on formalising the sector (it is highly fragmented currently and dominated by smaller independent stores) in an effort to increase Saudi participation. That said, we believe consumer discretionary companies which offer more affordable and economic goods could benefit as they take market share.

3. **Rising focus on healthcare provision:** Saudi Arabia is focused on significantly growing accessibility to healthcare for its residents. The provisions in the NTP include a significant increase in medical centres (hospitals and clinics), wider provision of private health insurance and an increase in the level of

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pharmaceuticals manufactured locally. We thus see potentially strong opportunities for the private hospital operators, the health insurance providers and local pharmaceutical manufacturers.

4. **An improvement in the availability of affordable housing for Saudi nationals:** The Saudi housing shortage has been a persistent issue for the country; with the shortfall currently standing at an estimated 1.2mn units, in our view. Looking forward, we believe this shortfall will likely intensify given strong demand formation. The NTP is seeking to introduce greater numbers of affordable housing units and greater availability of financing. Indeed, the ministry of housing is looking to invest cUS$16bn in achieving these aims by 2020. Whilst we do not believe these measures go far enough to fully resolve the housing shortage, we nevertheless see material opportunities for Saudi real estate developers.

5. **Growth in telecom/fibre infrastructure:** The NTP is seeking to greatly enhance connectivity in the country, largely through increased usage of internet. Reflecting that, the government has pledged approximately US$2bnn to significantly increase the availability of high speed FTTH networks in remote areas, increase mobile broadband coverage and density in urban centres (3G/4G) and allocate an increased amount of bandwidth to the mobile service providers. We thus see significant volume growth potential for the telecom service providers (particularly with regards to mobile data, where we see scope for price increases). Furthermore, we expect much of the capital expenditure required to expand the FTTH and Mobile networks to be provided by the private sector, which in our view will accelerate the case to spin off their tower portfolios (as a method of funding capex expansions).

6. **Significant growth in downstream petrochemicals capacity and metals & mining:** The NTP's drive to diversify revenues away from the oil sector has seen it focusing on exports of non-oil commodities. In particular, we highlight the significant investment it has earmarked for the downstream industries including petrochemicals and oil refining, as well as aggressively growing the country's metal and mining operations (likely through national champion, Maaden). Examples include the expansion of the country's base metals production (e.g. bauxite and phosphates) and the construction of an oils-to-olefins project. The further development of capital intensive industries also provides some scope for Saudi Arabia to develop service industries and increase local content provisions, in our view. These could be facilitated through joint-ventures with global service providers, who may consider manufacturing plants in Saudi Arabia.

How to gain exposure to NTP themes

In reflection of the themes articulated above (and in the sections that follow), we highlight the sectors and companies which have exposure to each of these themes in the table below. The companies highlighted in green represent the companies which are currently Buy rated by our fundamental analysts and also fit in with our theme of gaining exposure to the NTP.

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Chart 44: Summary of sectors and companies with exposure to key NTP themes (companies highlighted in green are rated Buy and represent our top picks)

	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5	Theme 6
	Religious Tourism	**Downtrading**	**Healthcare provision**	**Growth in Affordable housing**	**Telco infrastructure growth**	**Increase in none-oil commodity exports**
Sectors to benefit	Travel & Tourism	Consumer staples	Private Hospitals	Real Estate	Telecoms	Petrchemicals
	Transport	Consumer Disc.	Insurance co's	Construction	Training & Education	Metals & Mining
	Consumer staples	Training & Education	Pharma	Banks		Industrials
	Training & Education		Training & Education	Training & Education		Training & Education
BofA ML coverage with exposure	**STC**	**Savola**	**Al Hammadi**	Dar al Arkan	**STC**	**SABIC**
	ZAIN KSA	Almarai	Dallah		**Zain KSA**	Maaden
	Savola	**Al Othaim**				**Yansab**
	Almarai	**Al Hokair**				Safco
	Al Othaim	Jarir				
Other Companies with exposure	Mobily	Sadafco	Mouwasat	Emaar Economic city	Mobily	Petrorabigh
	Sadafco	Halwani Brothers	Care	Saudi Banks	Al Khaleej Training	Zamil
	Al Tayyar	Nadec	MEAHCO	Al Khaleej Training		Al Khaleej Training
	Dur Hospitality	Saudi Marketing	Spimaco			
	Saudi Ground Serv.	Al Khaleej Training	Bupa			
	Saudi Catering		Tawuniya			
	Al Khaleej Training		Med Gulf			

Source: BofA Merrill Lynch Global Research

Saudi market valuation not testing

The Saudi market has been one of the poorest performing emerging markets year-to-date, underperforming the MSCI EM indices by approximately 10% (and c20% since August 2015). A combination of weak oil prices and their inevitable impact on the Saudi economy including slowing economic growth, rising operational risks and fiscal consolidation (including subsidy removals) have been the key drivers. The underperformance has left the market trading on a 12mth P/E of c.13x, an 11% discount to its long term average and its lowest premium to GEMs since 2010 (Saudi trades on a 7% percent premium vs long run average of c. 30%). Furthermore, Saudi trades on 12mth FWD P/B ratio of 1.5x, a 20% discount to long run averages, but a 15% premium to GEMs on 1.3x, justified by the market's higher ROE's (Saudi's long term P/B premium has been c.25%). Finally, Saudi trades on 12mth FWD EV/EBITDA multiples of 9x, a c.11% discount to long run averages.

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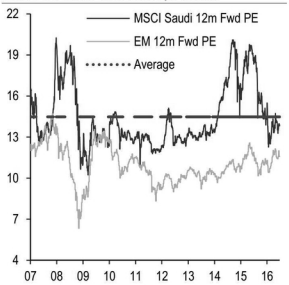
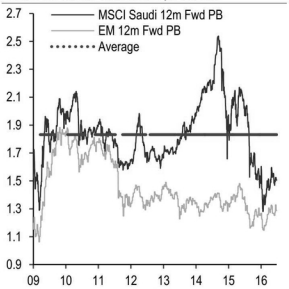
Chart 45: Saudi 12m fwd. P/E vs. EM



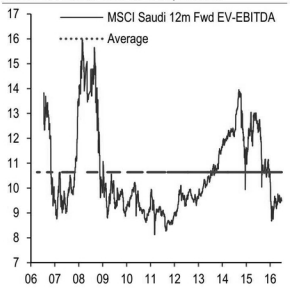
Source: DataStream, I/B/E/S, Bloomberg, BofA Merrill Lynch Global Research

Chart 46: Saudi 12m fwd. P/B vs. EM



Source: DataStream, I/B/E/S, Bloomberg, BofA Merrill Lynch Global Research

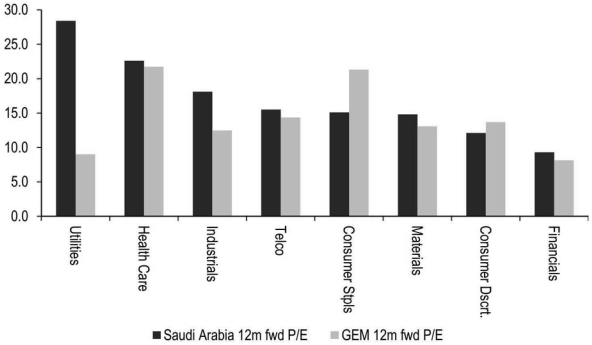
Chart 47: Saudi 12m fwd. EV/EBITDA



Source: DataStream, I/B/E/S, Bloomberg, BofA Merrill Lynch Global Research

Interestingly, not all sectors within the Saudi market trade at a premium to GEM peers, with both consumer discretionary and consumer staples trading at a material discount. The remaining sectors all trade at a modest premium to their GEM counterparts, with the industrial and utility sectors trading at a substantial premium on 12mth FWD P/E

Chart 48: Consumer sectors trade at a discount relative to GEM averages. Industrials and Utilities are relatively expensive vs. GEM peers, other sectors trade at small premium



Source: DataStream, I/B/E/S, Bloomberg, BofA Merrill Lynch Global Research

Weaker economic outlook largely priced in as ERR shows inflection

A further consequence of the weakening economic outlook for Saudi Arabia has been the collapse in market expectations, with earnings estimates having posted their longest sustained period of downgrades on record. We note however, the Saudi Earnings Revision Ratio (ERR) has reached an inflection point, with a slowdown in the rate of earnings downgrades. (ERR is a ratio of number of companies enjoying earnings upgrades vs number of companies suffering downgrades. A ratio above one, therefore, indicates more upgrades than downgrades). Consequently, we believe the relatively untesting valuations of the Saudi market indicate that a high level of negativity is already being priced in.

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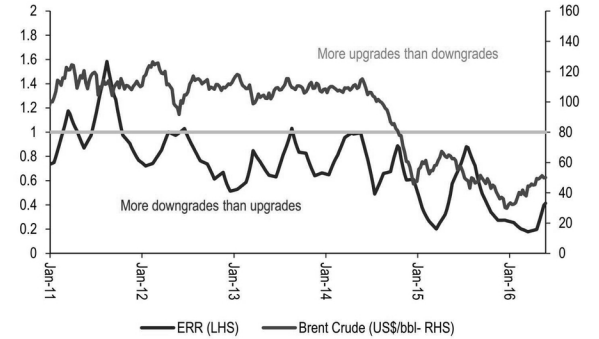
Chart 49: Saudi ERR's are showing signs of inflecting despite one of the most protracted periods of earnings downgrades.

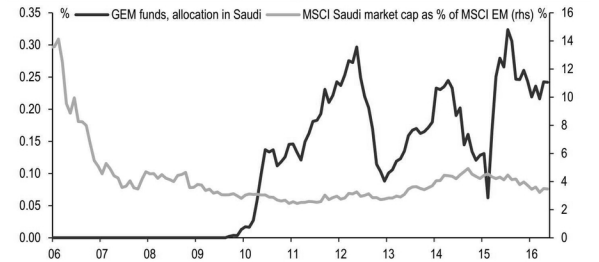


Source: DataStream, I/B/E/S, Bloomberg, BofA Merrill Lynch Global Research

Off benchmark and out of mind? Growing confidence could drive rerating

With Saudi Arabia remaining off benchmark (it is not currently part of any major indices such as the MSCI EM or FM), GEM funds allocation to Saudi Arabia remains relatively low at just 0.25% (of total GEMs AUM). Whilst allocation levels are relatively high versus history, they are still significantly below the levels implied by MSCI EM inclusion (1.4%) or suggesting a level of apathy towards the market.

Chart 50: GEM fund allocation in Saudi (asset-weighted)*



Source: EPFR, BofA Merrill Lynch Global Research.*Market cap as % of MSCI EM represents and artificially constructed benchmark weight assuming that this market was a member of MSCI EM index

With the NTP looking to diversify the Saudi economy away from the oil sector (and reduce its reliance on a higher oil prices), we believe confidence in the longer term economic outlook could improve, ultimately driving earnings momentum and a market rerating. Given our view that crude oil prices will likely post growing momentum in 2017, moving substantially above US$50/bbl, even a partial success of the NTP program would likely be sufficient to improve market confidence.

CMA reforms (likely linked to the NTP), a potential catalyst for market rerating

Furthermore, reforms being introduced by the Saudi Capital Markets Authority (CMA) to attract greater foreign participation in the Saudi market (see below) indicate Saudi is

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seeking an expedited path to inclusion within the major Stock indices. Given the NTP is seeking heavy involvement/investment from the private sector, we believe the measures introduced by the CMA to attract direct capital inflows to the country are likely linked with the larger NTP process. Growing confidence in the CMA's market reforms and the potential for inclusion in the major indices could prove to be a meaningful basis for the market to rerate upwards.

Taking positive steps to accelerate MSCI inclusion

The Saudi Capital Markets Authority recently announced extensive changes to the Qualified Financial Investor (QFI) program, which should ultimately increase the ease of foreign access to the Saudi market. In particular:

(1) Individual foreign investors will now be allowed to own up to 10% of the equity in a company (up from 5%). The total limit on foreign ownership remains at 49%.

(2) CMA decreased the minimum AUM of QFIs to US$1bn from US$5bn (although funds with AUM's below this level will be considered by the CMA).

(3) CMA introduced stock lending & covered short selling;

(4) CMA extended the settlement cycle to T+2 from T+0, effectively eliminating pre-funding;

(5) CMA effectively removed the concept of a QFI client, which would have prevented investors from using multiple fund managers to gain exposure to Saudi Arabia. This highly restrictive clause was a significant reason why many global institutions did not seek to gain QFI status; and

(6) CMA significantly reduced the amount of bureaucracy required to apply for and retain QFI status.

MSCI inclusion one step closer as accessibility increases

In our view, the range of measures the CMA is looking to adopt greatly enhances the accessibility of the Saudi Stock exchange and as such bring Saudi Arabia one step closer to inclusion in the MSCI EM index. Whilst we continue to see inclusion most likely from 2019 (with an announcement in 2018), the new changes indicate that a 2018 inclusion (with an announcement in 2017) is by no means out of the question. Indeed, whilst the timing of introduction of these new measures is likely to be 1H2017, a recent release of the draft proposals from the CMA suggested it could come as soon as 3Q16; although we await further clarification.

A higher weighting in international indices

Saudi Arabia is currently under consideration for inclusion in the MSCI EM index, potentially as soon as May/June 2018; although we believe 2019 is more likely. Saudi Arabia is currently not included in any of the Major global indices and as such its inclusion would have a profound effect on the market as it:

(1) leads to significant inflows of capital in to the market from both active and passive funds following the MSCI EM index and;

(2) significantly increases interest in the Saudi market as it gains profile and is no longer seen as off benchmark.

We see these factors as compatible with the NTP aim to boost capital markets.

Currently Saudi would be 1.4% of MSCI EM = US$10.9bn of inflows.

As per MSCI's guidance, we use MSCI's standalone Saudi market index as a template (released May 12th 2015) for Saudi stocks to be included in the MSCI EM index. The MSCI Saudi index currently contains 19 stocks (all listed entities on the Tadawul market) which are likely for inclusion in the MSCI EM index (were Saudi to be included). By taking the total market cap of these companies and multiplying them by the foreign

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inclusion limit articulated by the MSCI (currently 0.2), we are able to decipher the relative weighting of Saudi Arabia if it were to be included the MSCI EM index.

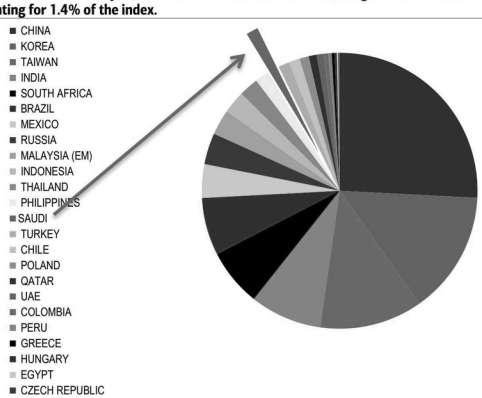
This analysis suggests that Saudi's potential weighting in the MSCI EM Index (were it to be included today) would be c1.4%. Furthermore, it would likely trigger net inflows (from other MSCI EM markets) of US$10.9bn when including all passive and benchmark-neutral active funds tracking MSCI EM. Importantly, our analysis is based on EPFR data, which respectively indicates US$405bn and US$354bn of active and passive funds following the MSCI EM index.

Table 14: Provisional MSCI Saudi Arabia constituents stand to gain as much as $10.9bn of total passive and benchmark-neutral active funds on inclusion

	Provisional weight in MSCI Saudi	Provisional weight in MSCI EM	ADTV active (US$m)	Potential buying (US$m)	Potential active days buying	Potential passive buying (US$m)	Potential passive days buying	Total US$m active + passive days buying	Total days active + passive days buying
AL RAJHI BANK	9.5%	0.1%	37.2	546.5	14.7	477.7	12.8	1,024	27.5
ALINMA BANK	2.0%	0.0%	223.0	116.9	0.5	102.2	0.5	219	1.0
ALMARAI	4.4%	0.1%	7.7	255.8	33.1	223.6	28.9	479	62.0
ARAB NATIONAL BANK	2.0%	0.0%	1.4	113.6	81.7	99.3	71.4	213	153.2
BANQUE SAUDI FRANSI	2.8%	0.0%	1.3	163.1	122.7	142.6	107.2	306	229.9
ETIHAD ETISALAT CO.	2.2%	0.0%	11.9	126.1	10.6	110.2	9.2	236	19.8
RABIGH REFN.& PETROCH.	1.0%	0.0%	9.2	59.1	6.5	51.7	5.6	111	12.1
RIYAD BANK	3.4%	0.0%	2.0	195.6	100.3	170.9	87.7	367	188.0
SAMBA FINANCIAL GROUP	4.0%	0.1%	5.0	232.9	47.0	203.5	41.1	436	88.2
SAUDI ARABIA FRTZ.	2.6%	0.0%	4.4	148.2	33.5	129.5	29.2	278	62.7
SAUDI ARABIAN MINING	4.5%	0.1%	17.2	260.8	15.1	228.0	13.2	489	28.3
SAUDI BASIC INDUSTRIES	25.3%	0.4%	170.9	1459.4	8.5	1275.6	7.5	2,735	16.0
SAUDI ELECTRICITY	8.4%	0.1%	6.3	485.3	77.3	424.2	67.6	910	144.8
SAUDI TELECOM	13.4%	0.2%	9.5	774.7	82.0	677.1	71.7	1,452	153.6
SAVOLA GROUP	2.0%	0.0%	6.9	114.4	16.6	100.0	14.5	214	31.2
YANBU NAT.PETROCH.	2.3%	0.0%	6.7	134.5	20.2	117.6	17.7	252	37.9
FAWAZ ABDULAZIZ ALHOKAIR	1.0%	0.0%	5.7	55.5	9.7	48.5	8.5	104	18.1
ALTAYYAR	0.8%	0.0%	33.5	44.4	1.3	38.8	1.2	83	2.5
NATIONAL COMMERCIAL BANK	8.2%	0.1%	6.8	474.8	70.1	415.0	61.3	890	131.4
TOTAL				**5,762**		**5,036**		**10,798**	

Source: BofA Merrill Lynch Global Research, MSCI and DataStream

Chart 51: If included today, Saudi Arabia would be the thirteenth largest constituent of the MSCI EM, accounting for 1.4% of the index.



Source: : BofA Merrill Lynch Global Research, MSCI and DataStream

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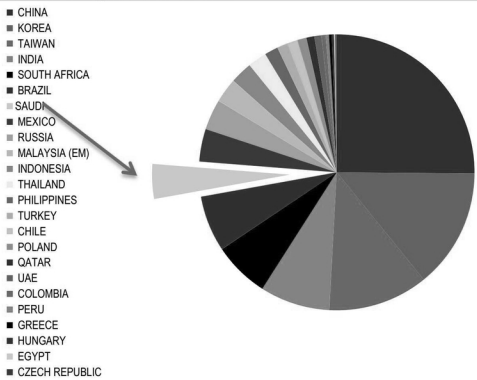
Privatisations & ownership limits could increase weighting

However, our analysis of Saudi Arabia's weighting could be significantly understated for two reasons, including: (1) our analysis currently uses a foreign ownership limit (FOL) of 0.2 (as previously guided by the MSCI). This could be understating Saudi's weighting given the increase in foreign ownership introduced in the CMA's announcement. Indeed, if we increased our FOL factor to 0.4, Saudi would be 2.8% of the MSCI and could attract US$21.3.bn of inflows; and, (2) Saudi Arabia (according to local press and the NTP) is seeking a number of privatisations in the coming 24 months, including a potential IPO of Aramco. Inclusions of these companies would likely increase Saudi's weighting in the MSCI EM index and thus attract higher inflows to the market.

Inclusion of energy assets could see Saudi accounting for 4.1% of MSCI EM

By way of example, we believe inclusion of Saudi Aramco in the Saudi market would profoundly affect the weighting of Saudi Arabia in the MSCI EM in our view. Indeed, if we were to replicate the analysis above using the Deputy Crown Prince hypothetical valuation of US$2tn for Saudi Aramco and a 5% inclusion factor (given 5% or less of Saudi Aramco would be listed according to interviews with the Deputy Crown Prince), Saudi Arabia would account for 4.1% of the MSCI EM index and likely attract cUS$31bn of inflows from passive and active funds. We note, our calculations are highly sensitive to the inclusion factor that MSCI would ultimately use (we assume 5%, in line with its estimated free float of 5%). An inclusion factor of 10% for example, would see Saudi Arabia accounting for 6.6% of the MSCI EM index.

Chart 52: If energy assets were included, Saudi Arabia would be the seventh largest constituent of the MSCI EM, accounting for 4.1% of the index



Source: BofA Merrill Lynch Global Research, MSCI and DataStream

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Telecom: supporting a move to higher connectivity

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Table 15: Key NTP objectives for the Ministry of Communications and Information Technology

No.	Strategic objective	Key Performance Indicator (KPI)	Unit	Baseline	2020 target	Regional b'mark	Int'l b'mark
1	Provide critical resources, especially frequency spectrum for Information telecommunications and Technology services	Percentage of frequency spectrum available for telecommunication services out of the total allocated telecommunication services	%	42	80	NA	>90
2	Provide broadband services to all KSA regions by stimulating investment in infrastructure and developing tools, technical and regulatory frameworks	Percentage of FTTH coverage in densely populated urban areas	%	44	80	>95	>90
		Percentage of FTTH coverage in urban areas	%	12	55	>90	>80
		Percentage of wireless broadband networks' coverage (more than 10 Mbps) in remote areas	%	12	70	NA	74
3	Develop and activate smart government transactions based on a common infrastructure	Maturity level of the government services transformation to e-services	%	44	85	NA	NA
		KSA's rank in the United Nations index for the development of e-government	%	36	25	18	11
4	Bridge the digital gap in the skills of ICT users	Percentage of internet users in KSA	%	63.7	85	90.4	87.9

Source: National Transformation Plan

NTP helps increase penetration of higher margin offerings

We believe the National Transformation Plan will herald significant change for the Saudi telecom sector over the next five years. In particular, its focus on increasing access to high speed internet (via wireless and fibre) should underpin a material uplift in data usage and broadband penetration levels. Given these offerings represent the highest margin services provided by the telecom service providers, we believe the move towards a more data intensive society should be supportive for industry margins. Furthermore, with the NTP's plans relying heavily on private sector investment (including STC), we believe it could accelerate the spin out of tower portfolios from the three telecom players in the Kingdom (as a way of raising financing).

Government investment set to exceed US$2bn

As part of the National transformation plan, the government is seeking to invest more than US$2bn in the expansion of wireless (3G & 4G) and fibre infrastructure (FTTH) across the kingdom. Whilst the finer details on how this expenditure will be deployed (e.g. via grants or via direct investments?) have yet to be disclosed, details of the NTP suggest it will be used to expand connectivity in the remote areas of Saudi Arabia (given the telecom companies have largely avoided such expenditure in the past given low returns), as well as increasing network density in developed and urban areas.

Spectrum increases an indication of ambitious growth

The government is also looking to significantly enhance the availability of spectrum to the telecom industry (from 42% to 80% of total spectrum allocated), highlighting the expected surge in data usage in the Kingdom to 2020 and beyond. Whilst data usage in the Kingdom has been rapidly growing in recent years on the back of high speed rollouts (3G & LTE), demand still lags global and regional averages (as indicated by data as a percentage of total mobile revenues). Ultimately, we believe this will have a number of effects including: (1) Saudi Arabia will further increase its focus on high speed offerings, (LTE/LTEA and eventually 5G); (2) capex cycles will likely lengthen as telecom companies intensify their rollout of coverage; and, (3) tower density will likely have to increase across the key demand centres.

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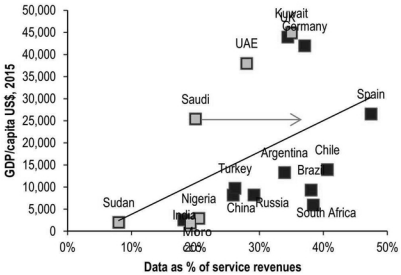
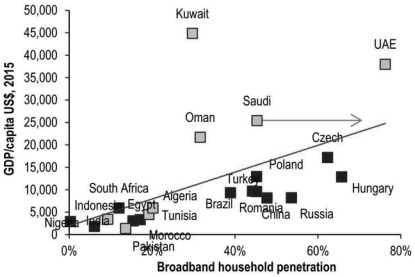
Chart 53: Data as % of mobile service revenues



Source: BofA Merrill Lynch Global Research, Telegeography and company data

Chart 54: Household Broadband penetration



Source: BofA Merrill Lynch Global Research, Telegeography and company data

Private sector participation and investment will be crucial...

Whilst the government has earmarked cUS$2bn for the expansion of FTTH and wireless infrastructure (with a view to ultimately increasing internet usage), we believe this will likely be insufficient to meet the needs of the NTP's ambitious targets (based on costs of rolling out existing wireless and FTTH networks). As such, we believe the private sector (Zain KSA, Mobily and STC) will be key contributors to the financing of the expansion plan.

...intensifying the case for creation of a Saudi tower company

The Saudi telecom service providers have invested heavily in rolling out high speed wireless networks and, in the case of Mobily and STC, FTTH networks (not to mention license costs). This has seen the balance sheets of both Mobily and Zain KSA reaching relatively high gearing levels; thereby limiting their ability to step up capital expenditure for a sustained period. Consequently, we believe the focus on raising capital (to fund the expansion programmes) from the spin out of their Tower portfolios will only increase. We see **Zain KSA** as the key beneficiary of this given they have the most highly geared balance sheet amongst Saudi Telco peers.

Mobile market share gains for Zain KSA and Mobily increasingly important

Whilst the Saudi government has taken steps to introduce competition in the telecommunications industry, its moves to open the market have thus fallen short of this objective. Specifically, government-owned STC retains more than 60% revenue market share in Saudi Arabia, giving it a dominant position in the market, whilst Mobily and Zain KSA have only managed to achieve c25% and 15% revenue market share respectively.

This, in our view, has likely been driven by a number of factors including: (1) the relatively high cost of market entry (ie licenses) for both Mobily and Zain KSA, which has lumbered both with high operating costs; (2) high royalty costs, which amount to c16% of revenues generated in Saudi Arabia (with some exceptions, including data), arguably inhibiting requisite marketing and infrastructure spend. We note both Mobily and Zain KSA remain loss making; and, (3) the relatively high mobile termination rates, which arguably afford an advantage to STC and prevent Zain or Mobily from competing more aggressively on price.

For the realisation of the NTP, we believe it is important that all private sector players are realising sufficient rates of return and FCF generation to be able to finance the requisite growth in infrastructure. We note both Mobily and Zain KSA were loss making in 2015 and are expected to return sub 5% ROE's in both 2016 and 2017 (according to

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Bloomberg consensus estimates) vs. STC at 17% (consensus). It is thus arguably crucial for Zain and Mobily to be allowed to increase market share in the mobile arena. We thus believe the regulator (CITC) regulator will have to consider further steps to afford market share to the second and third entrants including asymmetric competition measures (pricing, MTRs), license extensions or differentiated royalty rates.

STC the likely beneficiary of FTTH expansion

Whilst we argue that STC could lose further market share in the Mobile market as a result of regulatory moves, we believe the negative impact will be offset by growing revenues from FTTH, IPTV and the corporate market. Indeed, we believe STC, given its market leading FTTH network and IPTV offering, will likely benefit most acutely from the growth in the number of FTTH customers. Furthermore, with government grants likely to be provided for FTTH roll out in less economical areas (as part of the NTP), we believe returns will likely not suffer from the additional capital deployment. Mobily could also benefit (given its well-developed FTTH infrastructure), although we expect it to lag STC who has a first mover advantage and arguably a stronger FTTH/Triple play offering.

We note, Zain KSA will unlikely participate in the rollout of the FTTH expansion given its constrained balance sheet and strategic focus on the wireless market. That said, the company could benefit from the rollout of high speed internet solutions over its wireless network (ie fixed broadband over its 4G network), particularly in areas where the construction of FTTH networks maybe be difficult or uneconomical.

Royalty rate increases unlikely, particularly for Zain KSA and Mobily

Admittedly, an increase in royalties could be an easy way of raising much needed revenues for the government. After all, each 1% increase could raise income by more approximately SAR500mn (cUS$130mn). However, we would argue that this is unlikely given the lack of sufficient competition in the market and the obstacles to increased competition higher royalty rates would introduce. In the same vein, we also believe it highly unlikely that the government would seek to introduce a fourth mobile operator license given the lack of sufficient market capacity between the second and third operators.

Religious tourism a material opportunity for telecom providers

Saudi Arabia's ambitious growth targets for religious tourism provide a material opportunity for the telecom providers in our view. More specifically, if the number of religious tourists (for Hajj and Umrah) increases by an estimated 10mn per annum by 2020, we believe demand for roaming services (voice and data) and sim purchases will increase significantly. Indeed, on our estimates, we see the 10mn visitors potentially providing a SAR2bn-SAR4bn opportunity, representing a c4-8% uplift in total wireless revenues for service providers. We particularly believe **Zain KSA** will benefit strongly from this given they provide the most competitive Pay as you go packages currently and have the largest spare capacity on their network.

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Health: Not Tremendously Prescriptive

Vision 2030 a start but Needs Transparent Proposals

The Saudi government's Vision 2030 document calls for an improvement in healthcare in Saudi Arabia. The private healthcare sector has some role to play; the National Transformation Plan (NTP) targets the private sector to be responsible for funding 35% of healthcare spend in 2020, up from 25% today. How it intends to do this is uncertain. We believe the incumbent private hospital operators, including listed companies (Al Hammadi, Care, Dallah, MEAHCO and Mouwasat) should be beneficiaries of increased private sector funding, although increased investment would be needed to meet growth in demand longer-term.

Improve public facilities, work towards privatisation

The government wants to step back from financing and providing healthcare and adopt an oversight and regulatory role. Firstly the government wants to improve the quality of care offered in the public sector, with the eventual aim of working towards privatisation of public assets and healthcare provision. This implies no privatisations short-term.

Near-term: Management contracts for public hospitals

In the near-term the government could seek to improve healthcare provision in the public system by using private sector expertise, through, e.g. contracting management of public facilities to the private sector. Individual such contracts are unlikely to transform company earnings, and the small size of existing Saudi hospital groups limits the depth of management available to capture large contracts, in our view.

Long-term: insurance coverage up to 31m from 10.5m

In the long-term a widespread adoption of private health insurance is likely to raise volumes, spurring an increase in private healthcare capacity, either from organic investment or participation in privatisations. In Saudi currently, 10.5m/31m people have insurance. We assume a more universal scheme would offer lower pricing than that today, and listed incumbents would need to make a cultural shift towards addressing this market. Such a market could attract new competitors, domestic or foreign.

Type of insurance system and reimbursement uncertain

We believe reimbursement levels would need to be known before privatisations can occur so bidders can budget and estimate their return on capital. It is still uncertain whether the government would seek to introduce insurance through the incumbent private operators (Bupa Arabia, Medgulf and Tawuniya) or set up its own insurance company e.g. an Abu Dhabi-style Daman. Nor whether it would subsidise premiums or simply force the private sector to employ more Saudis.

Government needs to improve private sector relations

At present the government has not paid private hospitals for the treatment of public patients referred to them for over a year. Until the relationship improves, engaging with the private sector could be difficult.

Healthcare implications of National Transformation Plan

The Saudi government's Vision 2030 document calls for an improvement in healthcare in Saudi Arabia. The private healthcare sector is likely to be a beneficiary both in the short-term and long-term. In the short-term the National Transformation Plan (NTP) targets the private sector to be responsible for funding 35% of healthcare spend in 2020, up from 25% today. In the longer-term, the Saudi government wants to remove itself from directly providing and financing healthcare, instead focussing on public health and the regulation of the healthcare sector. Raising private sector funding thresholds to 35% appears possible if a number of measures are used, e.g. more rigorous enforcement of requirement that Saudis working in private sector hold insurance could increase penetration by 6% alone. The quality targets set for the public sector do not appear unduly onerous in theory, but execution remains key.

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What the Vision 2030 announcement said on healthcare

Transfer the responsibility for health care provision to a network of public companies

Promote competition and transparency between public and private companies to enhance the standard and quality of health care services

Prepare for privatisation in the longer term.

Work towards developing private medical insurance to improve access to medical services and reduce waiting times

Table 16: National transformation Plan objectives for the Ministry of Health

No.	Strategic objective	Key Performance Indicator (KPI)	Unit	Baseline	2020 target	Regional b'mark	Int'l b'mark
1	Increase private sector share of spending through alternative financing methods and service provision	Percentage of Private sector contribution in total healthcare spend	%	25	35	37	60
2	Increase the efficient utilization of available resources	Opex for every new inpatient admission	SAR	33,000	33,000	39,000	NA
3	Improve the efficiency and effectiveness of the healthcare sector through the use of information technology and digital transformation	Percentage of Saudi citizens who have a unified digital medical record	%	0	70	NA	100
4	Increase training and development both locally and internationally	Number of resident Saudi physicians who are enrolled in training programs	Number	2,200	4,000	NA	NA
5	Increase the attractiveness of nursing and medical support staff as a preferred career path	Number of qualified Saudis in the field of nursing and support staff for every 100,000 people	For every 100000	70	150	460	1,106
6	Improve healthcare provision before hospitalization and in the main hospitals (ER & ICU)	Percentage of patients who received emergency or urgent care with medical decision made (admission/ transfer/ discharge) in less than 4 hours in key hospitals	%	40	75	Under study	95
7	Improve integration and continuity in service provision by developing the primary care	Number of primary healthcare visits per capita	Number	2	4	3.4	7
8	Improve the infrastructure, facility management, and safety standards in healthcare facilities	Number of licensed medical facilities (affiliated with the Ministry of Health and private)	%	40	100	100	100
9	Attain acceptable waiting times across all stages of service delivery	% of appointments received in specialized medical disciplines within 4 weeks (average for all specialties in key hospitals)	%	<40	70	Under study	83
10	Improve governance in the health system in order to enhance accountability with regards to quality issues and patient safety	% of Healthcare facilities reporting comprehensive performance and quality measures	%	10	100	NA	100
11	Adopt a national plan for emergency response to public health threats per international standards	WHO emergency preparedness assessment score – average score for Riyadh, Jeddah and Eastern Province	Score	Calculation In Progress	4-5	Under study	Under study
12	Identify additional sources of revenues	Total revenue generated from private sector for utilizing government health resources	SAR bn	0.3	4	NA	NA
13	Improve public health services with focus on obesity and smoking	Increase in percentage of smoking incidence	%	Calculation In Progress	Reduce by2% from baseline	12.5*	10.5*
		Increase in percentage of obesity incidence	%	Calculation In Progress	Reduce by1% from baseline	19.4*	5*
14	Improve the quality of life and healthcare service provided to patients outside hospitals	The percentage of patients who get health care after critical care and longterm hospitalization within 4 weeks	%	25	50	NA	65
15	Improve quality and safety principles as well as skills of service providers	Percentage of hospitals that meet the US median for patient safety culture	%	10	50	NA	50

Source: Saudi National Transformation Plan

SAR23bn budget allocated for the MoH's NTP programmes

The Ministry of Health (MoH) has been allocated SAR23bn for the transformation plan over the next five years, with any contribution from the private sector on top. Over half (56%) of the funds have been allocated to reform of primary healthcare and to the establishment of electronic medical records. Only 4% of funds (SAR937m) have been allocated to health insurance.

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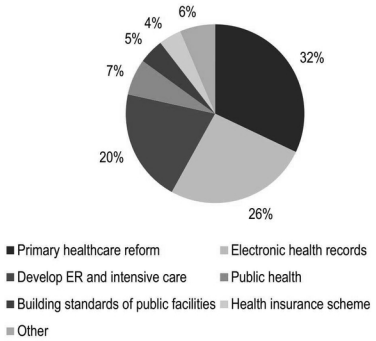
Chart 55: The MoH has been allocated SAR23bn over five years under NTP



Source: BofA Merrill Lynch Global Research, NTP

Government currently payor and provider

The government currently directly funds public hospitals, which provide free healthcare for citizens. The typical flaw with a unified system is that increased efficiency is not necessarily sought or rewarded. Employer-provided healthcare insurance is mandatory for both Saudis and expats working in the private sector, as well as their dependents.

Significant scope for increase in insurance coverage from 10.5m to 31m people

Saudi currently has a population of 31m, of which 10.5m have health insurance, a 34% penetration rate. Bupa Arabia believes another 2.5m Saudis who work in the private sector (including dependents) don't have health insurance but should have. Assuming the government increases enforcement, near-term penetration could increase to 42% of the population even with extra reforms.

Strain in relations between government/private sector

The government has not paid private providers who have treated government patients for a year, which is hardly going to encourage the private sector's further involvement, particularly those companies that have seen the biggest increase in their receivables (Al Hammadi and Dallah). However, the government can still put considerable pressure to bear on the sector to achieve its aims if it so wishes.

Increased Saudisation could be used as a policy

The easiest way for the government to increase private financing of healthcare to 35% from 25% would be to raise Saudisation requirements. Under Saudisation, the government sets a minimum proportion of a company's staff that must be Saudi citizens, which differs by industry sector. Increased Saudi employment in the private sector short-term would put the onus of financing healthcare onto employers. However, such a move would likely pressure private sector margins.

Increase pressure on employers to trade down on insurance

The impact of Saudisation as a mechanism would likely be negative for pricing although positive for volumes, assuming the hospital has the capacity to accept more patients. Employers would likely seek to trade down in terms of the insurance schemes they offer in a bid to reduce their involuntarily raised expenditure. Insurers would seek better deals with hospitals as a result and could seek restricted network arrangements to curtail

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costs. Hospitals would be under pressure to be more flexible on prices to avoid any pressure should lower-cost packages impact their volumes.

Vision implies a long process

To us, the government's vision implies a two stage process over a long time-frame:

- **In the short-term:** improve the quality of care offered in the public sector, potentially with the assistance of private healthcare
- **In the long-term:** Only when public facilities have improved, privatise such facilities (although one medical city is to be privatised under a public-private partnership)
- **Concurrently:** Prepare for a roll-out of private health insurance to finance private provision

Abu Dhabi and Dubai are probably not parallels

In Abu Dhabi and Dubai, private healthcare was encouraged to avoid expats relying on public facilities. The large expat population in proportion to the locals (85:15) supported the creation of private facilities that it was then possible for the governments to fully fund Emiratis to use. The quality of public facilities was not a cause for concern - many Emiratis still prefer to use government facilities for more serious problems.

Expat population and quality of public system differ in Saudi

The proportion of expats (33% of the population) is not large enough to drive the establishment of a large, high quality private hospital base sufficient to serve the entire Saudi population. Additionally, the quality of both care and infrastructure in the public system is seen as lacking, suggesting additional investment in facilities is required.

Degree to which private sector will benefit is uncertain

Given the lack of detail provided to date, it is hard to assess the benefits, or risks to the incumbent private hospital operators in detail. We see two main ways the private sector can participate in healthcare reform:

- Win contracts to run and improve public health facilities
- Benefit from volume growth any roll-out of private health insurance could spur
- Participate in privatisations

In the long-term, volumes up but pricing down, likely to benefit nonetheless

At present there is limited supply of quality private hospitals and the incumbents are in a strong bargaining position with insurers. Greater private hospital supply, and competition, would likely pressure pricing, and margins in the longer-term, albeit offset by increased volumes. Assuming only basic services are offered to most citizens under any government-driven scheme, there would still be a place for offering higher-quality accommodation for example, to higher-income patients.

Private sector could win public hospital contracts

Private operators could be allocated management contracts for public hospitals to improve efficiency of existing hospitals, train public sector administrators and raise clinical standards. Presumably reimbursement under such contracts would be based on a fixed fee, potentially with performance clauses for improved outcomes or lowering costs. More substantive contracts, where the private operator is responsible for all aspects of operating the hospital could be more accretive, but bring greater financial risk.

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Table 17: Examples of management contracts

Company	Contracts
Dallah	Dallah has had two types of hospital contracts. One, which just involves management expertise, was worth SAR4.5m over five years and 10% of the hospitals income. The other was worth SAR89m over five years but in this Dallah was responsible for all staffing and supplies and infrastructure operation and maintenance.
Mouwasat	Mouwasat managed Najd consulting hospital in Riyadh in return for management fees of c.SAR3m per year; this was subsequently changed to receiving a share of revenues and net profits.
NMC	NMC was awarded a contract to manage a government hospital in Umm Al Quwain, UAE. The five year contract sees it earn $5m (SAR18m) in fees per year, subject to certain performance criteria being met. During the term of the contract NMC is to train government staff to which it will hand over administration at expiration.

Source: BofA Merrill Lynch Global Research, company report

Private groups may lack capacity to undertake such contracts

The private hospital groups in Saudi Arabia are small. Habib Medical Group, Mouwasat and Middle Eastern Healthcare group are the largest, with only 8, 5 and 4 hospitals respectively. We would question whether any company has the depth of management to undertake management of a large number of government hospitals. Potentially the government could seek to import foreign expertise.

Insurance roll-out likely to boost private volumes

Longer-term, the roll-out of private insurance would likely have a positive impact on volumes available for incumbent operators to capture. This will depend though on the available capacity of private operators at that time and level at which reimbursement is set. The current listed operators typically target high income patients and a lot of the growth in volumes would likely be in the low-to-middle income spectrum.

Cultural shift would be needed to target larger population at lower price point

It would require a clear cultural shift for the incumbent listed hospital operators to switch from offering a high quality service to high income individuals to operating facilities that served the wider population at what we presume would be a much lower price point.

Investment is difficult until pricing and reimbursement is clarified

Until reimbursement levels are clarified, existing private operators/investors will not be able to make decisions on investing in private healthcare facilities.

Privatisations seem unlikely in the near-term

Given the stated intention to improve the quality of hospitals prior to privatisations, it seems unlikely there will be any near-term, although the NTP does call for privatisation of one of the medical cities in a public-private partnership. Saudi operates a number of medical cities, which are typically collections of hospitals that act as tertiary referral centres. The largest of these is the King Fahad medical city in Riyadh, with 1,095 beds. It is uncertain which city is planned for privatisation. As with further investment by private operators in new facilities, the level of reimbursement would need to be clarified so potential bidders can estimate their return on investment from participating.

270 public hospitals in Saudi currently

Latest available data (2014) from the Saudi Ministry of Health discloses 270 public hospitals with 40,300 beds. Of these, 47 hospitals are in Riyadh, with 25% of the population, and 13 hospitals are in Jeddah, which holds 14% of the population. Presumably these assets would be the most valuable during a privatisation process, not only because of the population sizes, but also because the provision of beds hasn't kept up with population growth, ensuring high demand. Both areas also host the highest number of private hospitals in the country.

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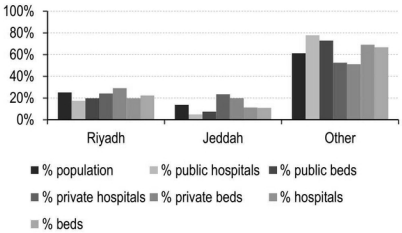
Table 18: Public and private hospital and bed distribution

	Riyadh	Jeddah	Other
Population	7,717,467	4,224,568	18,828,340
Public			
Hospitals	47	13	210
Beds	7,937	2,993	29,370
Beds/hospital	169	230	140
Private			
Hospitals	34	33	74
Beds	4,554	3,109	8,001
Beds/hospital	134	94	108
Total			
Hospitals	81	46	284
Beds	12,491	6,102	37,371
Beds/hospital	154	133	132

Source: BofA Merrill Lynch Global Research, Ministry of Health

Chart 56: Public and private hospital and bed distribution



Source: BofA Merrill Lynch Global Research, Ministry of Health

Hospital quality would be key to attracting private buyers

The government has not invested in hospital infrastructure and some hospitals may require substantial investment by any buyer, if they are acquired at all. One Saudi hospital operator has said that there is no way it would seek to acquire government hospitals for that reason.

Bidders would likely want to obtain scale benefits from multiple purchases

Operating hospitals has benefits of scale in terms of centralising certain non-medical services (e.g. purchasing, catering, laundering) and allocating central costs over a greater revenue base. The greatest financial benefit would come from acquiring groups of hospitals to maximise these benefits. There would likely be cases where staff, and/or high net worth individuals chose to bid for individual assets.

Privatisation proceeds could defray some of NTP cost

Amounts raised from any privatisation would reflect the degree of competition for individual assets as well as level of reimbursement and the profits any acquirer could generate. In terms of pure asset values we assume the Riyadh and Jeddah hospitals (60) would be worth more than those elsewhere (210), simply because of the greater population currently and higher expected future growth. Government hospitals are likely lower cost than that of private facilities given they are not competing on the quality of accommodation offered. Arbitrarily assuming US$100m for hospitals in Jeddah and Riyadh and US$50m elsewhere would imply proceeds of $16.5bn (SAR61bn). If every hospital were sold then it could more than cover the SAR23bn allocated to the MoH for the NTP. That seems unlikely however; there will be hospitals that require substantial investment and aren't worth the indicative figures we have used above, or are in areas where profitability means there will be no return for the private sector at that level of acquisition.

Reforms could attract additional competition

Incumbent private hospital operators are best placed to expand and are seen as the natural buyers of any privatised assets. However, any substantial privatisation process, or the potential created by widespread adoption of private health insurance in general, could attract interest from foreign investors or operators. We note only a small number of international hospital groups to date have experience of successfully operating in multiple countries (IHH, Mediclinic), and we think Saudi Arabia could be too challenging as a first step for those yet to operate outside their domestic market.

Structure of insurance market needs to be set

There are a number of ways the government could roll-out private health insurance more widely:

- Set up its own insurance company

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- Work with existing private insurers
- Use a back-door approach and just force private employers to hire more Saudis

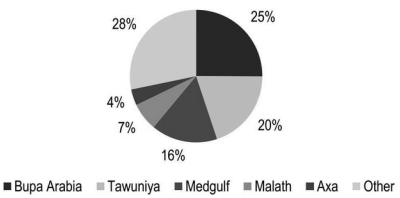
The government could set up a state insurance company

The government could set up a single-state insurer that is either funded through direct contributions or through general taxation. The government would likely need to get external help from a party knowledgeable in insurance and risk, which could be an insurer, Saudi or otherwise. Daman, Abu Dhabi's health insurer is owned 80% by its government and 20% by German insurance company Munich Re.

Existing private insurers may not have capacity if they were made responsible

The government could decide to execute any financing scheme through existing private insurers, or give citizens the option of choosing either a government or private insurer. The existing private healthcare insurers in Saudi Arabia are unlikely to have the resources (both people and systems) in place to provide cover for an additional 20m people immediately and will need some time to prepare. Any large scale immediate expansion could put them at risk of substantial underwriting losses that they would presumably seek to have back-stopped by the government in the initial stages.

Chart 57: Health insurers by share of claims (1H15)



Source: BofA Merrill Lynch Global Research, CCHI

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Consumer: a necessary pain

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The Saudi government initiatives taken in the National Transformation Plan (NTP) will transform the Saudi consumer landscape. We note a mixed effect on the sector:

- On the positive side, we anticipate 1) job creation for Saudi nationals in the private sector with a big focus on Small and Medium Enterprises (SMEs); 2) a strong emphasis on education; 3) an ongoing increase of the participation of women in the workforce; 4) an increase of the percentage of self-sufficiency in broiler production which should ultimately support local producers; and, 5) a significant pick-up of the religious tourism during Haj and Umrah.

- On the negative side, we anticipate 1) a rationalization of subsidies for water and electricity; and, 2) a more competitive retail environment, more open to international players, attracting foreign direct investment (FDI).

Prefer staples over discretionary

While slowing consumer credit and weaker private sector consumption growth amid a young population do not support Saudi spending in both staple and discretionary items, we expect staple-related stocks such as Al Othaim and Savola to be better positioned to capture the marginal consumption. This is principally due to their exposure to necessities (food items) in a very fragmented market. Having said that, we expect more pressure on the opex of all Saudi consumer corporates, while revenue growth outlook will remain subdued in the short-term given the weaker consumer confidence and disposable income.

A more moderate growth outlook; Saudi female workforce drives private sector

Following a 12% 10-year CAGR fuelled by the rise in household income, we conclude that the retail sector will continue to play an important role in the rising participation of the Saudi workforce, women in particular (10,000 in 2010 vs 120,000 in 2014 according to the Ministry of Labor) supporting their disposable income in the long-term. Overall, the Saudi retail sector is one of the largest employers in Saudi Arabia with 1.5mn workers (17% of the Saudi workforce) of which low-cost foreign workers represent 80%. This implies that Saudis working in the retail account for 300,000 (40% are female), doubling in 4 years.

Needed reforms: better macro at the expense of micro

While we acknowledge that the targets set by the government are paving the way for the right reforms (development of the private sectors, a more competitive economic landscape, attraction of FDI), we expect the Saudi retail outlook to be marked by a slower growth in the coming years. In particular, we highlight few major challenges for the effective implementation of the plan: 1) incentives to enrol Saudis into consumer-related jobs suggesting rising opex pressure for consumer stocks; and, 2) 20% public payroll cut will put pressure on Saudi disposable income in the short-term given than c80% of the Saudi workforce is in the public sector.

Key strategic objectives and Key Performance Indicators (KPIs) to watch

The National Transformation Plan (NTP) outlays several strategic objectives and related KPIs to watch by ministry which we believe will impact the Saudi consumer universe:

- The Ministry of Economy and Planning is looking to 1) expand privatization of governmental services; 2) increase the efficiency of government subsidy programs; 3) establish specific zones with competitive advantages to enhance investments;

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and, 4) develop tourism and entertainment sector. To do so, the ministry mainly targets to decrease the subsidy for water and electricity by SAR200bn by 2020 and to expand the private sector contribution to GDP from 40.5%.

- The Ministry of Commerce and Investment is looking to 1) reinforce the protection of the Saudi consumers; and, 2) develop SMEs by incentivizing the culture of entrepreneurship and supporting productive families. The ministry targets by 2020 to 1) more than double the number of established entities from 50k to 104k; and, 2) increase the contribution of SME to non-oil GDP from 33% to 35%.

- The Ministry of Environment, Water and Agriculture is looking to 1) optimize the use of renewable water resources for agricultural purposes; and, 2) support national companies. The ministry targets by 2020 1) to consume more than twice less water in the agricultural sector, which should be reflected in a lower percentage of water used in the agricultural sector relative to the total available renewable water resources (191% vs 416% today); and, 2) to reinforce the Saudi independence to the broiler production by increasing the percentage of self-sufficiency in broiler production to 60% from 42%.

- The Ministry of Haj and Umrah is looking to provide the opportunity for the largest number of Muslims possible to perform Haj and Umrah. The Ministry targets by 2020 the number of Haj pilgrims to increase from 1.5mn to 2.5mn and the number of Umrah Pilgrims from abroad to increase from 6mn to 15mn.

- The Ministry of Labor and Social Development is looking to 1) improve education and enable more Saudi nationals to enter the job market; and, 2) to increase the participation of women in the workforce. The ministry targets by 2020 to 1) create 1.2mn jobs in the private sector (men and women); 2) reduce the unemployment rate to 9% from 11.6%; 3) reduce the cost of employment of Saudis compared to expatriates to 280% from 400% today, which implies a higher cost of expatriates; and, 3) to increase the proportion of female force to 28% vs 23% today.

Table 19: National Transformation Plan objectives and Key Performance Indicators (KPIs) affecting the consumer sector

Strategic objective	Key Performance Indicators (KPIs)	Unit	Baseline	2020 target	Regional b'mark	Int'l b'mark
Ministry of Economy & Planning						
Increase efficiency of government subsidy programs	Value of water and electricity subsidy decrease	SARbn	0	200	N/A	N/A
Expand privatization of governmental services	Private sector contribution to GDP	%	40.5	N/A	20/27	36.4
Ministry of Commerce and Investment						
Boost entrepreneurship	Number of established entities (LLC)	#	50000	104000	N/A	347015
Boost SMEs	Contribution of SME to non-oil GDP	%	33	35	60	N/A
Ministry of Environment, Water and Agriculture						
Optimize the use of renewable water resources for agricultural purposes	Water used in the agricultural sector relative to total renewable water resources	%	416	191	42.76	19.1
Maintain security of vital resources of the country	% of self-sufficiency in broiler production	%	42	60	80	140
Ministry of Haj and Umrah						
Accommodate larger number of Muslims to perform Haj	Number of formal pilgrims (domestic and foreign)	mn	1.5	2.5	N/A	N/A
Accommodate more Muslims to perform Umrah	Number of Umrah Pilgrims from abroad	mn	6	15	N/A	N/A
Ministry of Labor and Social Development						
Provide suitable jobs for citizens	Number of suitable private sector job opportunities for Saudis	000	0	1200	N/A	N/A
Provide suitable jobs for citizens	Saudi unemployment rate	%	11.6	9	N/A	5.8
Provide suitable jobs	Cost of employment of Saudis vs expatriates	%	400	280	N/A	N/A
Empower women	Proportion of female labor force	%	23	28	N/A	N/A

Source: Saudi National Transformation Plan

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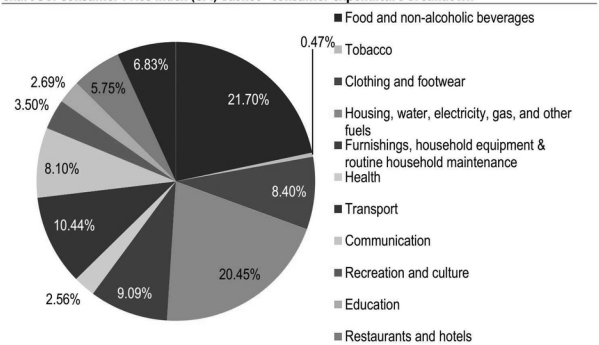
Rationalization of subsidies for water and electricity

The sweeping energy, water and electricity administered price changes introduced in December 2015 are a first step in the five-year fiscal consolidation and economic transformation strategy. We expect further reviews of energy, water, and electricity prices over the medium-term. Furthermore, the likely government review of current levels of fees and fines, introduction of new fees, application of a VAT and introduction of excise taxes on tobacco and soft drinks will also impact the Saudi consumer.

Subsidy cuts on energy and utilities to add up to 1.5ppt to CPI inflation only

We estimate the December natural gas price hike on petrochemical firms, domestic crude oil price hike as well as the combined gasoline and diesel price hike introduced could add US$2.2bn, US$2.0bn and US$3.8bn to central government revenues if fully passed to the budget (a combined 1.2% of GDP). We estimate the direct impact of these higher gasoline, water and electricity prices to add 1.3-1.5ppt to CPI inflation due to their low basket weights (c.1.5%, c0.4% and 1.6% respectively). We think a 5% VAT tax could add c2% of 2015 GDP in fiscal revenues over the medium-term.

Chart 58: Consumer Price Index (CPI) basket– consumer expenditure breakdown



Source: Haver, BofA Merrill Lynch Global Research

Subsidies account for 15% of Almarai's net income; 40% are related to poultry

Almarai continues to receive subsidies from the Saudi government, amounting to SAR295mn in 2015. This represents 15% of the Almarai's 2015 net income. The government pays subsidies based on price of subsidized feed importer, which means it may increase or decrease naturally. Regarding the breakdown by business (poultry, dairy), it is unfixed, depending on the price of feed and ingredients. As of 2015, subsidies for poultry accounted for 40% and dairy for 60%.

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Saudi Arabia approves 100% foreign ownership rules

- Saudi Arabia's cabinet has approved rules governing foreign ownership of retail and wholesale businesses in the Kingdom. The regulations, which were first discussed last year, allow foreign investors to own 100% of retail and wholesale businesses in the country. Earlier, the ownership ceiling for foreigners was set at 75%. This initiative is aimed at attracting more regional and international brands to Saudi Arabia, creating more jobs, and boosting non-oil revenue. This has raised concerns regarding the sustainability of the business model of Saudi retailers.

- Real estate is key to entering a market: unlike its peers, Al Hokair enjoys favourable access to prime locations in well-located shopping malls owned by its parent shareholder, Al Hokair Group. Fashion retailers such as Inditex continue to compete for good-quality real estate in shopping centres and on high streets.

- Jarir and Extra are more vulnerable to the entry of international retailers such as Apple as barriers of entry are very low for consumer electronics and appliances. Furthermore, the government emphasis on developing tourism and family entertainments (Six Flags, Sea World) represents a potential threat to Jarir and Extra's business models which still play an 'entertaining' role in Saudi Arabia.

- Such initiatives would result in (1) reducing the number of stores; (2) a rapid modernization of the sector; and, (3) a significant increase in labor productivity by adopting merchandising best practices.

Rationale for liberalization

The rationale for permitting FDI in retail trading is (1) attracting investments in production and marketing; (2) improving the availability of such goods for the consumer; (3) encouraging increased sourcing of goods from Saudi Arabia; and, (4) enhancing competitiveness of Saudi enterprises through access to global designs, technologies and management practices.

Typically, global retailers follow a 100%-ownership business model, which explains their reluctance to establish their presence in Saudi Arabia because of the restrictive policy environment. This has been reflected in the little amount of FDI received in the Saudi retail sector.

However, we do not believe that such decision will provide foreign investors more ability to have control of a company as the current ownership ceiling of 75% already allows them to pass both ordinary and special resolutions.

Key opportunities of 100% foreign ownership initiative:

We perceive several opportunities emerging from such an initiative:

1) **Capital infusion**: FDI is one of the major sources of investments for a developing country like Saudi Arabia wherein it expects investments from multinational companies to improve economic activity, create jobs, share their expertise, back-end infrastructure and research and development in the host country.

2) **Boost competition and dampen inflation**: the entry of the many multinational corporations will promise intense competition between the different companies offering their brands in a particular product market. This will result in availability of many varieties, reduced prices, and convenient distribution of the marketing offers.

3) **Improvement of supply chain:** Improvement of supply chain/distribution efficiencies, coupled with capacity building and introduction of modern technology will help arrest wastages, particularly in the food supply chain.

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4) **Jobs creation**: the entry of foreign companies into retailing in Saudi Arabia will not only create job opportunities but will also ensure quality in them, improving standards of living and life styles.

Al Hokair: Eased restrictions on foreign investors: perception vs reality

The liberalization of the Saudi retail industry raised concerns among Al Hokair investors regarding the potential loss of the Inditex franchise, which we estimate accounts for 8% of its total stores. We think this risk is overstated for the following reasons:

- **Relationship with parent**: Unlike its peers, Al Hokair enjoys favourable access to prime locations in well-located shopping malls owned by its parent shareholder, Al Hokair Group. The group owns and operates 13 shopping malls across Saudi Arabia (1.2m sqm of prime real estate) through its subsidiary Arabian Centres Company. However, we understand that rents are currently negotiated on commercial terms, thereby limiting the risk of a conflict of interest. We do not think the situation will change.

- **Real estate is key to entering the market**: Fashion retailers continue to compete for good-quality real estate in shopping centres and on high streets. Going forward, there is likely to be significant competition between these companies for new sites, especially in prime shopping centres, as they all require similar locations, typically prominent, wide-fronted premises. Zara, in particular, uses its shop windows to advertise its products.

- **Local manufacturing and distribution network would add execution risks and costs to international retailers such as Inditex**: While Saudi Arabia has not yet provided the details and conditions of the potential eased restrictions on foreign investors, we understand that the government is looking to attract investments, diversify its economy and improve Saudization. This means foreign retailers could be asked to set up local manufacturing and distribution networks within Saudi Arabia, which we believe could discourage retailers such as Inditex from entering the market directly.

More malls, less bargaining power with international retailers

The accelerating pace of mall developments in Saudi Arabia by regional competitors to Al Hokair's parent company suggests a rising risk of diminishing bargaining power for Al Hokair with its international brand partners such as Inditex. We expect Shumoul Holding 55% owned by Mabanee, the Kuwaiti mall operator, to develop a 400k sqm mall in Riyadh while Dubai-based Majid Al Futtaim recently announced that it is looking to develop two malls in Riyadh of 300k and 100k sqm of GLA respectively resulting in four times more stores (300) in the next five years. Such new entrants can then accommodate foreign retailers (such as Inditex), which could question the sustainability of Al Hokair's franchise model.

Jarir: exposed to NTP innovations

What if Apple enters Saudi Arabia

Should Apple enter Saudi Arabia, it would negatively impact the Apple resellers such as Jarir as the majority of the sales would be transferred to the Apple-branded stores. As such, we highlight 2 key risks to Jarir that would ultimately deteriorate earnings outlook: (1) rising competition from Apple resulting in a weaker footfall trend due to weaker electronic sales, which are key for store traffic; and, (2) intensifying competition from organised retail space (malls), reducing the market share of specialist retailers such as Jarir.

Jarir's earnings sensitive to electronics business

With c40% of revenues and c20% of gross profit derived from the electronics segment, Jarir remains vulnerable to the threat of foreign retailers entering directly Saudi Arabia.

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We estimate that a 20% decline in electronic sales would result in a 5% direct decline in gross profit. However, this ignores the other negative effects of other product categories due to a weaker footfall trend.

More entertainment in KSA, less attraction for Jarir's stores

In line with the guidance of the NTP, we expect Saudi Arabia to develop the entertainment sector (theme parks, cinemas). This signals the emergence of new aspirations and social changes for Saudis. While these developments will support implementation of Saudi Vision 2030, they will pose threats to the existing business models of Saudi retailers such as Jarir and Extra that are currently substituting for the lack of entertainment opportunities in the country.

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Real estate: NTP positive but not enough

The Saudi residential sector is suffering an acute housing shortage which we estimate at c1.2mn homes. Key reasons are:

- 1) **Land is expensive:** land constitutes as much as 50% of the cost of a housing unit which is more than double the typical 20-25% in more affordable areas globally.
- 2) **Affordability issue**: banks are reluctant to provide mortgages to workers from the private sector.
- 3) **Limited financing**: the Real Estate Development Fund (REDF) which used to provide interest-free loans to eligible Saudis for home purchase or construction, has been unable to cope with the demand for new loans and has a backlog of about 450,000 applicants. The housing ministry is looking to issue Islamic bonds to help fund the country's REDF at the end of 2017.
- 4) **Overrun development costs**: Long delays for construction approval and permits translate to overrun costs which create obstacles for developers to launch economically feasible projects.

A persisting shortage of affordable residential supply

The shortage of housing is not a new phenomenon – it has been ongoing for decades. The demand outlook from end-users is solid. Domestic household formation (marriages) is a large component: newly married Saudi couples need an affordable place to live. With market demand growing by 105K units pa (BofAMLe), we believe the shortage of supply will persist for the following reasons:

- **The limited scalability of residential projects** – Dar Al Arkan is the largest residential developer with only a 1% potential market share (delivery capability of 1,100 units pa).
- **The capital-intensive Saudi financing model** – without funding support from the government and a virtually non-existent off-plan sales market, Saudi developers have to secure funding to undertake larger residential projects. Dar Al Arkan is having to lever up, as land sales, which were once the primary source of funding, are no longer enough to enable it to scale up.
- **A lack of incentives for large regional developers to enter the market** – the dearth of off-plan sales has dried up the cash flows of developers and limited their ability to finance new projects and, in the worst cases, ongoing projects. Furthermore, the profitability of affordable housing projects is not compelling enough to attract developers to the Kingdom.

Fragmented Saudi residential market

Some 75% of new housing supply is from individuals and micro-home builders. This trend highlights Saudis' preference for building their own homes and illustrates the immature profile of the real estate market in Saudi Arabia. Sovereign actions in neighbouring countries, like the UAE, have boosted the sector (land granted to developers, capital flows from international investors). We see big developers becoming more active in the Kingdom but the effects on supply will not be immediate, in our view. So far, they represent only 15% of the total market.

Key strategic objectives and KPIs to watch

- The Ministry of Housing is looking to: 1) improve performance of the real estate sector and increase its contribution to the GDP; and, 2) enable citizens to obtain a suitable residence. The ministry targets by 2020 to: 1) double the real estate sector

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contribution to GDP from 5% to 10%; 2) reduce the average time required to approve and license new residential real estate; 3) reduce the housing unit cost from 10x to 5x of the gross individual annual income; and, 4) increase the real estate financing to non-oil GDP ratio from 8% to 15%.

- The Saudi Commission for Tourism and National Heritage is looking to increase and develop hospitality facilities and tourism services. The ministry targets by 2020 to increase the number of hotel rooms/apartments by 39% to 621.6k.

Positive government ambitions but...
The rise of real estate finance to non-oil GDP from 8% to 15% implies an incremental funding of US$32bn which could finance c212k additional units by 2020 or c53k additional units p.a. This compares to an estimated annual demand of 181k units which come on the top of the existing c1.2mn shortage of housing.

...needs to be combined with land tax and sukuk issuance initiatives
Based on the target Key Performance Indicators (KPIs) set for the Ministry of Housing, we estimate the initiative to be supportive but not sufficient to cater to the natural annual demand which is 3.5 times more elevated than the implied additional supply funded by the programme. We understand this initiative has to be combined with the land tax initiative and the potential sukuk issuance from the Ministry of Housing which could add further liquidity to the REDF to finance more units.

Land tax - gradual revenue source

Land tax among flagship measures adopted by the Saudi government
We expand more below on our understanding of the land tax initiative which was recently approved by the Cabinet to tackle the housing shortage and raise government revenues. Saudi Arabia's Cabinet announced in November 2015 that it will gradually levy a 2.5% tax on undeveloped land plots owned by persons or private entities in urban areas, after the country's Shura council approved a proposal to impose taxes on the so-called white lands. The draft law was amended to include gradual taxes in accordance with a specific timetable to force landlords to sell land, thus increasing land supply.

The regulations adopted in mid-June define undeveloped land as all vacant land dedicated to residential use or commercial residential use within the urban boundary limits. Fees will be applied to in a gradual series of stages; first, to owners of undeveloped land with areas exceeding 10,000 square metres; second, to single owners of developed land of more than 10,000 square metres in one master development plan; third, to single owners of developed land of more than 5,000 square metres in one master development plan; and, last, to single owners of land of more than 10,000 square metres in one city. The Ministry of Housing will determine the land locations where the tax will apply. The extension of the tax in later phases to developed land, from undeveloped ones at first, will broaden the tax base and minimize tax evasion.

Tax proceeds will be deposited in SAMA
The taxes and fines collected by the Ministry of Housing shall be deposited in the central bank, the Saudi Arabian Monetary Agency, and will be used to develop the country's infrastructure for new housing projects, according to the state-owned news agency.

Law could be effective this month, but gradual implementation likely
Under the new system, the housing ministry has been in charge of issuing executive procedures and rules for the new legislation within 180 days. The law will be effective 180 days after publication in the official gazette. The housing ministry is finalizing necessary amendments to the decree by end-June 2016 and aim for implementation by 17 January 2017 (including a 1-3 year grace period).

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Tax on land: a lever to lower real estate prices in urban areas

Given that the government is giving landlords a grace period in order to either develop or sell land to developers, we perceive the newly approved land tax as a lever to lower real estate prices. Ultimately, this would improve household affordability, reduce social tensions and indirectly tackling energy subsidies as it frees up potential household income to spend on electricity and gasoline.

Land tax could generate up to US$11bn/yr from the major urban cities

We estimate that the government could potentially collect up to US$11bn per annum of tax related to undeveloped land in the top 5 urban Saudi cities which accommodate more than 50% of the Saudi population. While the law will not be effective until end-2016, we do not expect the tax proceeds to be significant early on.

Table 20: Land tax proceeds estimates for the 5 major urban cities

Land tax could generate up to US$11bn per annum in first phase

City	Selected urban land area (sqm)	White land value (SARbn)	Annual Land tax proceeds @ 2.5% (SARbn)
Riyadh	1,300,000,000	494	12.4
Jeddah	1,686,000,000	481	12
Mecca	850,000,000	485	12.1
Medina	293,000,000	88	2.2
Dammam	200,000,000	48	1.2
Total	**4,329,000,000**	**1,595**	**39.9**

Source: SAMA, BofA Merrill Lynch estimates for white land and proceeds

Table 21: NTP objectives and KPIs affecting the real estate sector

Strategic objective	KPI	Unit	Baseline	2020 target	Regional b'mark	Int'l b'mark
Ministry of Housing						
Enable citizens to obtain a house	Real estate sector contribution to GDP	%	5	10	13	20
Improve performance of real estate sector	Average time required to license new residential new projects	Day/ Permit	730	60	44	26
Enable citizens to obtain a house	Housing unit cost multiples of gross individual annual income	x	10	5	6.7	3
Enabling citizens to obtain suitable housing financing	Real estate financing to non-oil GDP	%	8	15	16	75

Source: Saudi National Transformation Plan

Table 22: NTP government costs related to the consumer and real estate sectors

Consumer	SAR (000)
Ministry of Economy and Planning	3,293,255
Ministry of Commerce and Industry	4,313,050
Ministry of Environment, Water and Agriculture	13,942,405
Ministry of Haj and Umrah	333,600
Ministry of Labor and Social Development	7,931,710
Total	**29,814,020**
Real Estate	**SAR (000)**
Ministry of Housing	59,166,666

Source: Saudi National Transformation Plan

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Metals & Mining: ambitious growth target

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The NTP has focused on several areas relating to domestic drivers, i.e., housing, retail, trade and finance. However, a core part of the Saudi government's transformation strategy is to focus on expanding the Kingdom's mining potential. Saudi Maaden has historically been Saudi's mining champion, but the mining sector currently contributes only around 2% to the Kingdom's GDP. The NTP has set a high target for the sector: its contribution to GDP growing by 50% to SAR97bn by 2020 and sector employment increasing by 40% to 90k. While the first target could be achieved given the amount of capital that is currently being deployed in the sector, the latter part is questionable in our view as capital intensive projects are not the best means for employment generation.

Government focus on mining to boost jobs and growth

The focus on mining is driven by the ample and growing resources available. The Kingdom's largest mined products are phosphates, bauxite and gold. It supplies around 8% of global DAP production and has the largest integrated aluminium company in the world. Ma'aden continues to discover new gold and copper sites as well. We believe the outlook for mining is encouraging and the contribution to GDP targeted by the government could be achieved. We believe investments in this sector faces two hurdles:

1. Diversification – the base metal cycle lags that of oil but is eventually driven by the same global drivers (global growth). Furthermore, the NTP has currently set a low number for its capital commitments to the industry (US$82mn), achieving the targeted diversification and job creation at the moment seems to be highly dependent on attracting private sector capital. This would require attractive incentives schemes such as energy subsidies, tax exemptions or ease of issuing work permits for expats. However, at the moment, these have not been addressed by the Saudi authorities.

2. High capital intensity – for example, the government has spent close to US$21bn on Saudi Maaden but the company employs only around 6,000 permanent workers, of which Saudis account for nearly a third. While the build-up of this capacity does create a multiplier effect of almost 10x during the construction phase, most of the added jobs are usually low income blue-collar jobs that tend not to attract Saudis.

Domestic services sectors create more jobs than mining for dollars spent

We argue that capital spent on domestic services sectors is likely to yield more employment for dollars spent. A key example is Saptco, the Saudi Public transport Company, which has spent around US$450mn on assets and currently employs around the same number of permanent employees as Maaden, of which 1,200 are Saudis. We acknowledge that the technology and technical transfer will be different in an investment like Maaden versus Saptco, yet we believe the economic efficiency of using the mining sector as a means of generating employment is questionable.

NTP is already happening: Saudi Aramco has project to create 2,000 jobs

The plan to develop the mining industry is moving forward. Saudi Aramco has already announced its plans to build a downstream industrial complex along with GE and Cividale SpA. The complex will include the first-of-its-kind high-end forging & casting manufacturing facility and will serve the region's maritime and energy industries. The project will cost around US$400mn and likely generate around 2,000 jobs.

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Exports will largely depend on market conditions

Part of the NTP relies on growing Saudi exports, including that of the mining industry. While it is easy build a plant, the timing of when there projects come online and how it coincides with the cycle matters. The ability to dump will largely depend on the position on the cost curve, which seems to be fading with the recent reduction of subsidies.

The conglomerate model to continue

Saudi Arabia has historically adapted the conglomerate model to build up its industrial sectors, such as petrochemicals (SABIC), metals & mining (Maaden) and steel (Hadeed). We believe the government continues to focus on this model in its NTP plan and will use a number of vehicles to expand the sectors in question: Maaden in metals & mining and the new military company in defence.

Maaden has transformed from a pure gold producer to one of the largest conglomerates in Saudi Arabia at the moment. Through three key Joint-Ventures (JVs), the company is a top producer of DAP (Diammonium Phosphate) and gold and aluminium. The NTP clearly sets the stage for Maaden to grow even further but is unclear on how this is to be achieved and what it would mean for shareholders. Also, in our view, the all-in-one model has delivered subpar returns globally and the trend is towards the streamlining of operations and specialised vehicles. As an example, the largest petrochemical and agrichem companies, Dow and Dupont, plan to merge and then split into three different businesses, providing more specialisation. We can see the advantages of the specialised entity model as it provides cost synergies, efficiency and a clear strategy for the company. Also, in the conglomerate model, certain parts of the company are often dwarfed as other revenues streams represent a larger contribution to returns. Board and management could be more or solely focused on the sub-segment had if it is a stand-alone entity they have to monitor and manage, in our view.

Table 23: National Transformation Plan objectives in the mining sector

	Baseline	Target 2020	Regional benchmark	Global benchmark
Overall kingdom:				
Number of jobs created	65k	90k	75k	210k
Contribution to GDP	SAR64bn	SAR97bn	SAR13bn	SAR262bn
Number of localized technologies	Under study	125	NA	NA
Less developed regions in Saudi:				
Number of jobs created	0	12k	NA	NA
Expected contribution from private sector	0	SAR28bn	NA	NA
memo:				
Initiative cost to the government: SAR310mn (US$83mn)				

Source: Saudi National Transformation Plan

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Oil & gas/petchems: focus on downstream

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Focus on downstream expansion is a priority

An increased focus on downstream expansion is a strategic development priority in Saudi Arabia, with the aim of exploiting competitive advantages on feedstock costs and the strategic location. Furthermore, the government sees it as a mechanism to create job opportunities for nationals. We see the NTP natural gas target as optimistic as it faces many hurdles, while imports could be a better alternative which authorities now suggest they could be open to eventually.

Downstream chemicals represents the second largest focus of the NTP

The NTP is firmly focused on the integration of chemicals/refining/mining capacity into value-add downstream operations that would limit imports of certain products and provide technology transfer into the Kingdom. This accompanies the government's plans to expand its natural gas and refining capacity by 48% and 13%, respectively.

The NTP includes a sizeable allocation to the Royal Commission for Jubail and Yanbu, the government body that overlooks, promotes and develops the petrochemicals/energy-intensive/mining sectors in the Kingdom. The government plans to spend around US$10.9bn on developing various areas including: 1) the oil-to-olefins (OTC) complex in Yanbu; 2) colleges and institutes in Jubal Industrial area; 3) the necessary infrastructure in the community area of Yanbu Industrial City; and 4) value-add transformation industries in Raas AlKhair Industrial City.

Table 24: NTP focus for the Royal Commission of Jubail and Yanbu

Key focus areas	US$mn
Development of the OTC project	772
Development of colleges and institutes in Jubail Industrial City	731
Development of infrastructure in Yanbu	1,003
Development of residential areas in Jubail Industrial City	642
Development of Multi-Modal Logistics Hub in Yanbu Industrial City	543
Development, protection and rehabilitation of public facilities in Jubail Industrial City	954
Development of value-added transformation industries in Raas Alkhair Industrial City	805
Construction of Housing in Jubail Industrial City	538
Development of Mineral industries port in Yanbu Industrial City	556
Other infrastructure and projects (38 projects, size between 100mn to 500mn)	4,557
Total	**11,101**

Source: Saudi National Transformation Plan

Subsidies are likely to be needed

A key obstacle to building more refining capacity and a large OTC complex is the high capital intensity of such projects and the subsidies required to ensure an acceptable rate of return. We see the natural gas target as optimistic with many hurdles; importation could be a better alternative. We believe the government plans to reduce subsidies in water and electricity, but maintain them for feedstock prices as intensive natural gas production requires cheap gas to thrive. However, a move towards benchmarking to US gas prices is a likely and logical step, in our view. An alternative scenario would to mark natural gas prices in the Kingdom to the LNG netback out of Qatar. This would facilitate an additional US$2.5bn from the sector but would also put several companies at risk of becoming loss making (especially companies with a high content of heavy feed in their input mix). Should such a scenario take place, we believe implementation would be carried out over phases in order to allow companies to cope with the new pricing order.

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Table 25: Additional costs on petrochemical producers of higher feedstock prices

	Current scheme (US$50/bbl)	US Spot/(US$50/bbl)	Government revenues raised (US$bn)
Ethane	950	1,411	461
Methane	201	457	256
Propane	3,918	4,898	980
Butane	789	986	197
Naphtha	2,348	2,934	587
Ammonia	64	132	69
Feedstock cost	8,269	10,819	2,550
Electricity & water	1,039	2,053	1,014
Total	**9,309**	**12,872**	**3,564**

Source: IHS Chemical, BofA Merrill Lynch Global Research. US spot refers to natural gas prices of US$2.6/mn BTU. The US$2.5bn feedstock price rise could directly accrue to the central government through Saudi Aramco, while higher electricity and water charges would not.

Moving further down the value chain

Downstream operations in Saudi have historically been international Joint-Ventures (JVs) and government-owned entities like SABIC. In July 1993, the government issued a Royal Decree that merged all the state-owned refineries, distribution activities and marketing operations under Saudi Aramco.

This resulted in a transfer of the government's stake in three key refineries and international refining and petrochemical operations to one state-owned company. Today, Saudi Aramco is one of the largest crude oil refiners in the world and aims to become a top-three petrochemical producer through standalone petrochemicals facilities like Sadara, downstream integration at its many refineries, and potential acquisitions. The recent announcement of the US split with Shell was followed by comments that the breakup was due to different strategies by both companies with Aramco increasing its focus on petrochemicals.

Petrochemicals - a route to diversification

Saudi Arabia is emerging as one of the largest petrochemicals producers globally. The country initially started with integrated refining leading to petrochemical production through its multiple JVs in Saudi and other regions, and is now building the largest petrochemical complex globally. One of the goals is to maximise the value of the Saudi hydrocarbon chain. Ultimately, this expansion into petrochemicals should further support the diversification drive and thus support the stated goals for the Saudi economy.

Saudi Arabia (potentially through Saudi Aramco) aims to become a leader not only in commodity chemicals, but also downstream petrochemical conversion. In the cities of the Jubail and Rabigh, the Ministry of Energy, Industry and Mineral Resources (along with Saudi Aramco) is constructing value-parks next to upstream chemical facilities. The aim is to provide integration and the infrastructure for SMEs to operate and produce value-added products in the Kingdom. This diversification into specialty chemicals could increase returns from the current US$500/ton level to around US$2000/ton by 2040, according to local press citing senior Aramco officials. Saudi Arabia could also look to grow its international refining footprint to provide further integration opportunities, as was suggested by the recent split of the Motiva JV (Saudi is more keen to expand its downstream operations, whilst Shell is looking to reduce them).

Two petrochemical projects are also being built. The first is the Sadara project in Jubail, which is expected to become the world's largest integrated chemicals complex with 3MMt of output. It will use naphtha as feedstock. The second is Petro Rabigh II, which is the expansion project of the existing Petro Rabigh plant that will process 4MMt (93kb/d) of naphtha feedstock, and is planned to be launched in 2016.

NTP includes the long discussed Oil-to-Olefins (OTC)

Saudi's national transformation plan includes the development of a US$770mn industrial cluster whereby expansion to the Aramco refinery is likely to take place, providing the platform for the long discussed OTC, Oil-to-Olefins, project. Saudi

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authorities have highlighted in several press releases that Aramco and SABIC are looking at potential oil-to-olefins projects. The Kingdom has a proprietary technology that enables it to maximise the yield of olefins per ton of oil used. According to SABIC's management, this project has been carried out on a small scale at test sites and it is conducting feasibility studies at a larger-scale facility. Aramco has also highlighted plans in this area. While both companies declined to comment, Bloomberg highlighted that sources indicate they are assessing the possibility of embarking on a project together. Such a step would be the first of its kind in Saudi Arabia, with Aramco and SABIC working alongside each other on such a large scale.

Refining capacity target: almost there

The NTP aims to increase the refining capacity to 3.3mn bpd per day by 2020 from 2.9mn bpd today. Saudi has recently completed and launched two large refining projects with 400kbpd installed refining capacity each: (1) SATORP in Jubail launched in June 2014; and (2) YASREF in Yanbu – first shipment made in January 2015 and inaugurated in January 2016. In addition, it is building a new refinery, Jazan, which should process 400kb/d of Arabian heavy and medium crude oil; launch is expected in 2019.

Table 26: Saudi Arabia government refining assets

Name	Location	Completion	Refining capacity, kb/d	Saudi Aramco's share in capacity, kb/d	Saudi Aramco's ownership (%)	Partner
Wholly-owned domestic refineries						
Jeddah	Jeddah	1967	90	90	100%	n/a
Yanbu	Yanbu	1979	240	240	100%	n/a
Riyadh	Riyadh	1981	126	126	100%	n/a
Ras Tanura	Ras Tanura	1986	550	550	100%	n/a
Total			**1,006**	**1,006**		
Domestic refining JVs:						
SAMREF	Yanbu	1983	400	150	50.0%	ExxonMobil
SASREF	Jubail	1986	305	114	50.0%	Shell
Petro Rabigh I	Rabigh	1990	400	150	37.5%	Sumitomo (37.5%, free float 25%)
SATORP	Jubail	2014	400	250	62.5%	Total (37.5%)
YASREF	Yanbu	2015	400	250	62.5%	Sinopec (37.5%)
Total			**1905**	**914**		
Total in Saudi Arabia			**2,911**	**1,920**		
International refining JVs:						
S-Oil	South Korea	1991	669	424	63.4%	S-Oil
Motiva	USA	2002	1070	535	50.0%	Shell
Showa Shell	Japan	2004	445	67	15.0%	Shell
Fujian	China	2007	280	70	25.0%	Sinopec, ExxonMobil
Total			**2464**	**1096**		
Total capacity globally			**5,375**	**3,016**		

Source: Saudi Aramco, Energy Policy, BofA Merrill Lynch Global Research

Table 27: Saudi Arabia petroleum product output in 2014 (mn bpd)

	Saudi Aramco ownership (%)	LPG	Naphtha	Gasoline	Jet Fuel	Diesel	Fuel oil	Asphalt	Total
Wholly-owned domestic refineries									
Jeddah	100%	0.9	2.9	4.0	0.0	2.4	9.2	6.4	25.8
Yanbu	100%	2.4	3.2	11.5	-0.4	29.3	30.9	0.0	77.0
Riyadh	100%	1.8	0.0	10.9	2.7	19.2	0.0	6.5	41.2
Ras Tanura	100%	5.0	15.0	43.9	7.8	76.1	32.5	7.2	187.4
Subtotal		**10.1**	**21.1**	**70.3**	**10.0**	**127.1**	**72.6**	**20.1**	**331.3**
Saudi Aramco share in domestic JVs									
SAMREF	50%	-1.1	0.0	25.0	11.1	18.8	14.4	0.0	68.2
SASREF	50%	1.3	11.7	2.2	9.4	14.2	13.3	0.0	52.2
Petro Rabigh	38%	1.3	7.3	6.9	4.9	11.7	13.4	0.0	45.5
SATORP	63%	1.3	3.9	11.1	8.2	31.6	7.5	0.0	63.7
Subtotal		**2.9**	**22.9**	**45.2**	**33.7**	**76.3**	**48.6**	**0.0**	**229.5**
Total		**13.0**	**44.0**	**115.6**	**43.7**	**203.4**	**121.2**	**20.1**	**560.9**

Source: Saudi Aramco, BofA Merrill Lynch Global Research

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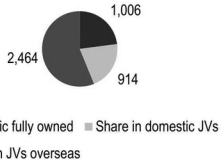
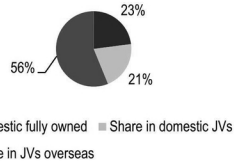
Chart 59: Saudi government refining assets (effective stake in k bpd)



Source: Saudi Aramco, BofA Merrill Lynch Global Research

Chart 60: Saudi refining breakdown per region (effective stake)

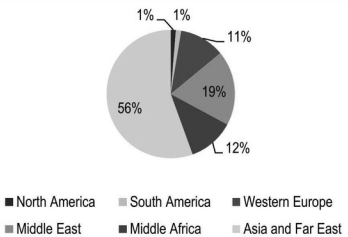


Source: Saudi Aramco, BofA Merrill Lynch Global Research

Exports are geared towards Asia and Far East

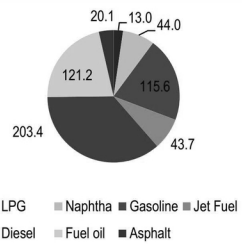
Saudi Arabia exported c.1mbpd of oil products in 2014, mainly to Asia and the Far East (56%), other Middle Eastern countries (19%) and Western Europe (12%).

Chart 61: Oil product export volumes split per region in 2014



Source: Ministry of Energy, Industry and Mineral Resources.

Chart 62: Saudi Arabia oil product slate in 2014



Source: Company data, BofA Merrill Lynch Global Research

Ambitious natural gas expansion

The NTP also focuses on expanding natural gas production. The government aims to grow the existing production by 48%, largely through non-traditional routes. According to the minister of Energy, Industry and Mineral Resources, natural gas accounts for 50% of energy production and the target is to increase this to 70% by 2020 through expanding local production or importing if necessary. The government's priority will be to explore the option of local production, although imports were, for the first time, not excluded. We consider this as an interesting development as importing LNG into Saudi costs the same as producing it internally through non-traditional routes, in our view. The Saudi statement acknowledges that Saudi Arabia is willing to be open to the possibility should imports provide a more economic means for this purpose.

Table 28: National Transformation Plan objectives in the petrochemicals, oil, and refining sectors

	Base line	Target 2020	Regional benchmark	Global benchmark
Oil production capacity (mn bbls/day)	12.5	12.5	3.8	11
Dry gas production capacity (bn scf per day)	12	17.8	5.7	16
Refining capacity	2.9	3.3	1.1	1.9
memo:				
Initiative cost to the government (total SAR491mn or US$131mn):				
Energy	SAR216mn			
Oil & Gas	SAR200mn			
Gas network	SAR75mn			

Source: Saudi National Transformation Plan

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Utility sector: sharing the capex burden and achieving cost reflective tariffs

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Eight strategic objectives aimed at being self-funding

The electricity sector is mentioned in eight strategic objectives of the NTP 2020. The two most important measures in our view are the one related to subsidies cuts and the one on the liberalisation of the sector which should free out financial resources to fund the future capex burden as well as the other targets under the NTP. This is even more relevant as the NTP doesn't provide any additional funding for the sector.

Unanswered questions as to impact on electricity sector

While we think these initiatives should be welcomed as they would reduce the financial burden on Saudi Electricity Company (SEC) from its ambitious capacity expansion plan (SAR240bn / US$64bn to be spent over the 2016-21, mostly in generation), some questions remain unanswered, especially in regards to SEC's capital structure and financial sustainability on a standalone basis. It remains unclear if the proceeds from the disposals of the minority stakes in the GenCos will be used to fund future capex plans or to alleviate SEC's commercial debt (US$16.3bn as of FYE15) and government and government-related debt and payables (c.US$46bn as of FYE16). Also, it remains unclear if on the back of the NTP, SEC would start paying its current payables (fuel sourced from Aramco, electricity sourced from SWCC and fees owed to municipalities) instead of accruing these amounts as it does now.

1. **Saving SAR200bn annually by cutting the water and electricity subsidies:** The current print of the NTP doesn't give any detail about how this target will be split between water and electricity subsidies, but we note that the plan aims to reach full cost reflective water tariffs by 2020 (from 30% cost coverage at the moment). Recall that starting from January 1st, electricity prices have been increased by a weighted average of close to 20%, with residential prices (half of the consumption) now ranging SAR 0.05-0.30 / KWh vs SAR 0.05-0.26 previously. The highest increases are for the commercial sector, the governmental entities and the agricultural sector. SEC's management recently indicated to us that they expect a neutral impact over the long term from this decision as it mirrors an increase in feedstock price charged by Aramco. However, over the short to medium term, SEC cash flows are expected to benefit from the tariff decision given that the company books all its fuel costs in payables without disbursing any amount to Aramco.

2. **Increasing the percentage of power generation through strategic partners to 100% from 27% now:** We believe that the aim here is to bring industrial or financial partners in all SEC's and Saline Water Conversion Corporation (SWCC) generation units, in line with the electricity sector reform which expected to be implemented by late 2016 / early 2017. According to SEC's management, the most likely scenario involves SEC's generation assets to be split into four separate regional GenCos where minority stakes would be sold to major global utilities or sold in the public market.

3. **Increasing the efficient use of "fuel" in power generation to 40% from 33% now:** We think that this objective entails increasing the share of efficient combined cycle gas turbines (CCGT) plants. Given that SEC currently represents 73% of the country's installed capacity and that 19% of its electricity is generated via efficient combined cycle gas turbines (CCGT), this means that 71% of the remaining tier party capacity is "efficient". We note that another 39% of SEC's installed generation capacity is made of less efficient open cycle gas turbines (OCGT).

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4. **Increasing the reserve to peak demand to 12% from 10% now:** This reserve margin was just at 2.3% back in 2012 and SEC was assigned a target of 10% which management expects to fulfil. In light of the recent improvements and SEC's ambitious capacity expansion plan (SAR240bn / (US$64bn in capex over the 2016-21), the target looks realistic to us.

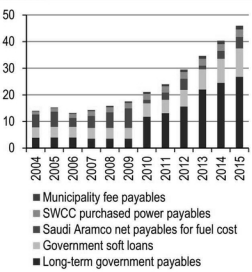
5. **Reducing the outages of more than 5min to 3.0 per year from 6.4 per year now and the average outage time to 120 minutes from 262 minutes now.** This goal will likely be achieved through the ongoing investments in expanding and improving SEC's transmission and distribution network (half of the overall capex incurred in 2015 went to these two segments).

6. **Increasing the access to electricity to 99.5% of the population from 99% now:** It is hard to quantify the cost of this objective, but we believe that it entails increasing the reach to the remote Eastern and Southern regions of the country where the economics of expanding the transmission network are not relevant.

7. **Reach 86 GW of installed capacity vs. 69 GW at the end of 2015 (incl. 50 GW at SEC alone):** The target is in line with SEC own current ambitious expansion plan (22.8GW to be added over five years to reach 68.3 GW by the end of 2018) and factors in additional capacity from SWCC and IPPs as well.

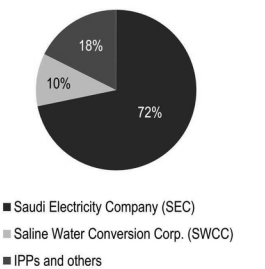
8. **Generate 4% of the electricity from renewables (equiv. to 3.45 GW):** we would expect the projects to be primarily based on onshore wind and solar. It is likely that these projects will be fully developed by IPPs under long term power purchase agreements where SEC would be the offtaker and assume the higher cost of the electricity from these RelPP. While SEC has currently no renewable generation capacity at all, it has recently invited expressions of interest for potential lead developers for two 50MW solar photovoltaic projects, which we see as a (modest) step towards the NTP target. Based on the KACARE study on grid impact, Saudi Arabia's electricity network should be able to integrate up to 14GW of renewables capacity by 2020. Finally, we note that ACWA Power, the largest privately-owned utility company in Saudi Arabia and one of the main IPP players in the country (along with Engie), has developed a proven expertise in wind and solar projects internationally. ACWA is likely to be one of the main players in the upcoming liberalisation plans.

Chart 63: SEC's debt and payables to the gov. & GREs grew at 17.4% CAGR since 2009 (US$bn)



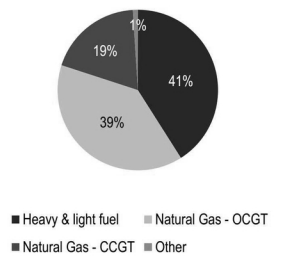
Source: SEC, BofA Merrill Lynch Global Research

Chart 64: Saudi Arabia power generation installed capacity split in 2015 (total: 69 GW)



Source: SEC, BofA Merrill Lynch Global Research

Chart 65: Saudi Electricity Company (SEC) fuel mix for electricity generation



Source: SEC

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Defence: Vision 2030 supports defence spending

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Saudi Arabia is increasing its regional role as a Security and Defence nation in the Middle East region. The 2030 Vision includes a higher local content in defence procurement which can be achieved through new contract awards and increased cooperation with large Original Equipment Manufacturers (OEMs). BAE is best positioned, in our view: it has been the in the country since 1966 with 5,000 local employees and Saudi Arabia represents 21% of BAE's group sales.

Saudi Arabia to build out military industrial base

Defence is one of the key industries that Saudi is pinpointing for investment as part of its future strategy plans, and one where it is well placed to become a global leader, in our view. Saudi Arabia has one of the largest defence budgets globally, and we expect its focus on defence investment to remain broadly intact regardless of the price of oil. Due to regional tensions, defence spending will likely remain high for the foreseeable future, in our view. Saudi Vision 2030 and the associated National Transformation Plan (NTP) will likely increase focus on use of defence to achieve their economic diversification goals. This is likely to take place through capability deployment and employment in partnership with long term defence partners. Saudi authorities aim to raise the locally-sourced defence procurement from 2% today to 50% in 2030.

Much of the countries' defence spending is for foreign imports. According to consultancy IHS, 1 out of every 7 dollars spent on defence imports in 2015 was spent by Saudi Arabia, which was predicted by IHS to increase its defence imports by 52%yoy to US$9.8bn in 2015.

In our view, Saudi strategy to increase locally manufactured defence content is justified, given their level of purchasing power with international contractors. However, this could trigger a round of new contracts' awards to set up new terms. The State owned Taqnia company has been signing some contracts with international companies but this remains very limited at this stage.

Saudi commitment to defence spending positive for European Defence

Saudi Arabia's Ministry of Finance 2016 defence budget spending remains high at SAR213bn (cUS$57bn) which is 25% of the total budget. In 2015, the budgeted defence spending reached SAR307bn (US$82bn). Despite the large decrease in headline defence and security expenditure, budgetary figures suggest the allocation for the Ministry of Interior, Ministry of National Guard, Ministry of Defence, General Intelligence Directorate, and Saudi Royal Guard Regiment could be heavily supported from elsewhere in the budget, if required. Figures released by the Ministry of Finance suggest that SAR183.0bn of the state budget for 2016 - c21% of total budgeted spending - will be allocated through a new 'Budget Support Provision' that is to be used "to give more flexibility to the budget and redirect capital and operational expenditure in line with national priorities and to fulfil spending requirements". In our view, the commitment to defence spending is positive for companies who have presence in the area, BAE (Buy, 600p) & Thales (Buy, €87).

BAE Systems ties to Saudi Arabia go as far back as 1966, when the company was contracted to Lightning and Strikemaster aircraft and equipment in a programme called the 'Magic Carpet'. In 1985, a new government-to-government (UK/Saudi Arabia) agreement was signed covering supply and support of Tornado, Hawk and PC-9 aircraft. A new government-to-government agreement, known as the Saudi British Defence Co-operation Programme, was inaugurated at the start of 2007. Salam Project, which

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provides for the acquisition of 72 Typhoon aircraft in a programme aimed at the modernisation of the Saudi Armed Forces, was launched in September 2007. This carries substantial packages of work and expertise transfers, aimed at developing the Saudi industrial defence sector. BAE Systems has made a major commitment to the training of local nationals to bring them into management, technical and other qualified positions. Saudis constitute 21% of BAE's group sales, 57% of the total BAE Systems' workforce in Saudi Arabia making the Company one of the largest private sector employers of Saudis with 5,000 employees based locally. The UK and Saudi have discussed in the past moving the final assembly of some of the 72 Typhoons in Saudi Arabia but it failed. Now, the two countries may be trying to have locally produced Hawks on the back of the 22 trainer order at the end of 2015, according to local press.

Thales (10% of group sales in the Middle East, mainly in defence) has an established presence in the Kingdom of Saudi Arabia, with 750 employees and a diversified portfolio of activities. The company has built a mature relationship with Saudi Arabia based on solid, country-wide partnerships. Thales's major commercial successes include the Shahine and Crotale air defence contracts with logistic support. In naval defence, Thales is the prime contractor for the Sawari II contract (three frigates), that follows on from the successful Sawari I programme (four frigates) for which Thales now provides logistic support. In 2007, Thales was selected by the Saudi Arabian Ministry of Defence to supply a major electronic protection system to the Royal Saudi Air Force.

US contractors such as Lockheed Martin (supplier of F16 jets, C130J transport planes), General Dynamics (military vehicles) and Raytheon (missiles) have some local presence in Saudi Arabia, but BAE is by in large the largest and historical local presence.

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Table 29: Stocks mentioned

Name	Symbol	Opinion	Q-R-Q	Price	PO
Al Hammadi	XBQYF	Buy	C-1-7	SAR 40.19	SAR 64.0
Al Othaim	XWPJF	Buy	C-1-7	SAR 99.99	SAR 121.0
BAE SYSTEMS	BAESF	Buy	A-1-7	GBP 483.4	GBP 600
BAE SYSTEMS	BAESY	Buy	A-1-7	USD 26.17	GBP 34.26
SABIC	XAUBF	Buy	C-1-8	SAR 80.87	SAR 99.5
Saudi Telecom	XUTUF	Buy	C-1-7	SAR 63.95	SAR 81.0
Savola	XSAVF	Buy	C-1-7	SAR 35.95	SAR 46.0
THALES	THLEF	Buy	C-1-7	EUR 73.5	EUR 87.0
YANSAB	XUYNF	Buy	C-1-7	SAR 40.28	SAR 48.0
Zain KSA	XOCTF	Buy	C-1-9	SAR 7.83	SAR 12.2
Almarai	XALRF	Neutral	B-2-7	SAR 53.7	SAR 61.0
Jarir	XJRIF	Neutral	C-2-7	SAR 118.64	SAR 134.0
SAFCO	XDUAF	Neutral	C-2-8	SAR 59.73	SAR 72.0
Dallah Healthcare	XJEFF	Underperform	C-3-7	SAR 86.12	SAR 79,0
Dar Al Arkan	XARKF	Underperform	C-3-9	SAR 6.49	SAR 7.0
Extra	XYDUF	Underperform	C-3-7	SAR 26.72	SAR 24.0

Source: BofA Merrill Lynch Global Research

Price objective basis & risk

Al Hammadi (XBQYF)

Our SAR64 PO for Al Hammadi is based on our DCF-derived valuation. This is equivalent to 32x FY17E EPS. Strong earnings growth means out-year valuations appear much more reasonable than near-term valuations (e.g. implied 13x FY20E EPS). Company specific risks are: lower-than-expected growth resulting from delays in executing on expansion plans, inability to raise prices to offset cost inflation, failure to manage growth without impacting margins, pricing pressure from insurers, new competition, sustained delays to government payments, and any potentially dilutive acquisitions. General/macro risks are: sustained low oil prices and any resultant slow-down in the economy, civil unrest, ongoing failure of the government to pay bills.

Al Othaim (XWPJF)

We use a combination of DCF, DDM and peer group analysis to value Al Othaim. We have taken a weighted average of values implied by our DCF, DDM and peer group analyses. We attribute a 50% weight to the DCF and 25% weights for both the DDM and the P/E multiple, which points to a PO of SAR121. We attribute a greater weight to the DCF valuation as we believe food retailers offer good visibility on cash flow generation. In the case of Al Othaim, we think DCF better reflects the stock's growth opportunity. We assume a perpetuity growth rate of 2% and WACC of 9.1% in our DCF.

The downside risks to our investment case are:
- Weaker-than-expected margin performance
- Cannibalisation effect in Saudi Arabia
- Competition: We expect competition to intensify among the large organized players, such as Savola-owned Panda which have aggressive retail expansion plans growth plan
- Saudization: Most of Al Othaim's labors are low level staff working in the warehouses and branches which depends heavily on expatriate labors. This suggests the Saudization of the staff could put further pressure on margins.

Almarai (XALRF)

We arrive at our SAR61/share price objective using a combination of P/E multiples and DCF valuation, taking the average yielded by the two methods. More specifically:

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On a multiples basis, we value Almarai on 21x 2017E EPS, a 15% premium to Global (blue chip) food producer averages. We believe that at this level it is fairly valued given it is trading at a premium to its historical trading average and the weaker consumer outlook.

Our DCF analysis yields a valuation of SAR59/share, based on a WACC of 8% and terminal growth rate of 3.5%.

Risks to our PO are company specific factors such as plant outages, disease outbreaks in its biological assets, delays in the investment program and factors affecting suppliers. Macro level risks are commodity prices, government regulation, subsidy removals and price pressures from growing competition.

BAE SYSTEMS (BAESF / BAESY)
Our PO of 600p (US$34.26/ADR) is an average based on DCF, 2016-17E P/E and EV/EBITA and Sum-of-Parts. We regard as BAE's peers Lockheed Martin, LLL, General Dynamics, Northrop Grumman, Raytheon, QinetiQ, Cobham, Ultra Electronics.

Our DCF valuation (8.7% WACC and 1.8% long-term growth rate in line with defence peers and 10.7% long term margin) implies a 550p share price. Our SOP suggests at valuation range of 592-595p, using peer group EV/EBITA multiples of 12.7-13.7x and EV/sales of 1.2x. Applying EU and US peers multiples on EV/EBITA and P/E yields a valuation range of 671-679p.
At 600p BAE would be trading on 14.6x 2016E P/E and at 13.9x 2016E EV/EBITA. This P/E is in the middle of the historical range of c.20x to c.6x, and the EV/EBITA is near the high end of the historical range of c.12x to c.4x.

Upside risks are: 1) An export contract for Typhoons, in particular an order for 60+ airplanes from Saudi, 2) USD strength against the UK, 3) development of a large scale and long term conflict.
Downside risks are: 1) significant decrease to the US or UK defence budgets, below our current assumptions, 2) significant weakness of the US$ vs Sterling.

Dallah Healthcare (XJEFF)
We set a SAR79 price objective for Dallah, which is equivalent to 23x FY17E EPS. We expect earnings to double between FY15A and FY20E as beds triple. The multiple therefore falls quickly and on FY20E earnings, when some of this growth is likely to have come through, the stock trades in-line with other hospital stocks, both EM and Saudi.

Upside risks are: greater price increases than assumed in forecasts, faster uptake of new capacity, accretive M&A activity.

Down side risks are: Slowdown in the economy, lower-than-expected growth resulting from delays in executing on expansion plans, inability to raise prices to offset cost inflation, failure to manage growth without impacting margins

Dar Al Arkan (XARKF)
Our PO of SAR7.0/share is based on sum-of-the-parts methodology. We employ a WACC of 10.7%, derived from a COE and COD of 11.1% and 9.0%, respectively. Our SOTP includes (1) the NPV of the current development portfolio to 2016E, (2) the NPV of recurring cash flows from investment portfolio + the NPV of its terminal value minus incremental capex to complete the investment programme, (3) the NPV of land sales from the developed land bank, and (4) the book value (valued at cost) of DAAR s remaining land bank.
Downside risks: (1) Deterioration of demand for land would increase the perceived liquidity risk (2) Deterioration of credit environment (3) Emergence

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of sub-developers which would inflate the acq. cost of land and consequently depreciate the residual value of land due to lower margins (4) Mismanagement of cash flows: a mismanagement of the resources (overspending in CAPEX for land for example) could arise liquidity concerns because of over-exposure to land sales mkt. Upside risks: A lower-than-expected borrowing cost: We forecast an incremental cost of debt of 9%, A improvement in the credit environment sensitive to exogenous factors such as liquidity and the risk appetite of the international mkt. would lower DAAR s cost of funding, We see upside valuation risk in the value of the land bank should the company manages to develop housing units with the support of the Ministry of Housing. debt-financed acquisition to boost its recurring income.

Extra (XYDUF)
We derive a PO of SAR 24 using a DCF valuation model which we believe best captures differing capital costs and growth profiles across the MENA region. Key assumptions are an 11% WACC and a 2% perpetuity growth rate. Upside/downside risks to our PO are better/worse returns from better/worse like-for-like sales and shorter/longer break even times from new international markets.

Jarir (XJRIF)
We derive a PO of SAR134 using a DCF valuation model which we believe best captures the company's plan to add c.60% new stores by 2017. Key assumptions are: - a 5-year CAGR in sales of 11% followed by an five-year CAGR of 6% and a perpetuity growth rate of 2%, - an average EBIT margin of 13%, - a WACC of 9.5% with a beta of 0.9x. Our WACC is calculated using a RFR of 5.0% and an ERP of 6.0%. We used a 2% terminal growth rate.

The risks to our PO are company-specific issues such as a failure to deliver the expected 11% top-line growth or a faster-than-expected deterioration in electronics margins. In addition, there are risks associated with a slowdown in the economy or consumer spending.

Saudi Arabian Fertilizer Company (XDUAF)
We apply a justified P/E multiple to derive SAFCO's PO of SAR72. The P/E is based on a normalized RoE of 30.2%, Cost of Equity of 10.4% and payout of 93.5%.

Upside risks to our price objective are: (1) delays in global nitrogen fertilizers capacity expansions, which would result in a tighter supply of urea and effectively higher prices, (2) Stronger demand for fertilizers and effectively prices, (3) An increase in the marginal producer cost that effectively leads to a higher urea price floor.

Downside risks are: (1) lower prices of urea due to weaker than expected demand, (2) Delay in SAFCO 5 expansion project, (3) an increase in natural gas cost.

Saudi Basic Industries Corporation (XAUBF)
We apply a justified P/E multiple to derive SABIC's PO of SAR99.5. The P/E is based on a normalised RoE of 15.8%, Cost of Equity of 11.5% and payout of 65.0%

Downside risks to our price objective are a decline in the supply of low-cost feedstock, a lower-than-expected recovery in petrochemicals prices, delays in the ramp-up of newly established subsidiaries, or weakness in steel demand in Saudi Arabia.

Saudi Telecom Company (STC) (XUTUF)
We derive our SAR81/share PO for STC on a sum of the parts basis, using a combination of DCF and market valuations for its core subsidiaries and associates, adjusting for ownership stakes. Specifically, we use DCF to value its core operations in Saudi Arabia (9.5% WACC), Viva Kuwait (10.5% WACC), and other subsidiaries (10.1% WACC). We

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assume a terminal growth rate of 2% across all of the markets, starting from 2023. For STC's associates, we value its holdings in Oger Telecom and Binariang using a combination of our Research team's valuation (for Oger's stake in Turk Telecom) and book value. We then add STC's net cash position at YE 2015 in deriving our PO.

Risks to our PO come from potential market share loss as both Mobily and Zain KSA, plus several MVNO's are aiming to take market share from STC domestically, following recent cut in MTR's. Additionally, we see ongoing risk from FX exposure at their subsidiary investments, especially their indirect stake in Turk Telekom.

Savola (XSAVF)
Given the diversified nature of the Savola group, we use a sum of the parts valuation in deriving our SAR46/share price objective for Savola. Specifically, we:

Value the food business on 12x 2016 earnings, a 30% discount to global peers on account have having slightly slower growth and risks presented by having a significant position in Iran (which accounts for 13% of revenues).

Value retail(Panda) at 15x 2016 earnings, a c.10% discount to global peers on account of having slower near term growth. we believe near term growth will be impacted by continued aggressive expansion and slowing demand trends in the Saudi market (following the introduction of the 2016 budget).

The investments business is valued using a variety of methods. For its stake in Almarai, we value it in line with our price objective for the shares. Savola's interests in other listed entities (Herfy, KEC and EEC) are valued at current market valuation given we do not have research coverage on the names. The stakes in none listed entities including the real estate book and private equity holdings are valued at 2x book value (YE2015).

Downside risks to our PO include higher cost escalation than we forecast, further adverse moves in commodity prices , adverse FX movements in countries outside of Saudi Arabia where Savola does business and any disruptions to its material Iranian business.

THALES (THLEF)
To derive our Thales price objective of €87, we use a 2017E sum of the parts valuation, using Rockwell Collins, Raytheon, Northrop Grumman, Ultra, and the EU Civil Aerospace peer group as peers for the Aerospace/defence segments, and Ansaldo STAS as a peer for the transport business.

At €87 Thales would trade on 18.1x 2017E P/E and 12.3x EV/EBITA which we think is appropriate given balance sheet/ portfolio optionality and building order momentum.

Upside/Downside risks to our price objective are: 1) changes in the company's free float, 2) assets swap and portfolio changes could add more value than we currently estimate 3) lower/more French defence cuts than we currently estimate.

YANSAB (XUYNF)
We apply a justified P/E multiple to derive YANSAB's PO of SAR48. The P/E is based on a normalized RoE of 14.5%, Cost of Equity of 11% and payout of 70%

Downside risks to our price objective are: 1. Lower-than-expected demand for polyester would adversely impact MEG prices and effectively earnings 2. Unexpected change in feedstock prices could negatively impact earnings 3. Unexpected shutdowns that would result in lower production.

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Zain KSA (XOCTF)

We use a DCF valuation model to derive our price objective of SAR 12.2. Key assumptions are a discount rate of 11.0%, underpinned by a risk free rate of 5.5%, a cost of equity of 29% and a 6.5% cost of debt. We explicitly forecast free cash flows until 2022 and then assume perpetuity growth of 3%, as we do when valuing other Gulf operators. Our forecasts take in to account the repayment of the deferred royalty loan afforded to Zain in 2013 (repayments starting from 2021).

Downside risks are greater pricing pressure from MVNOs, the loss of its appeal against a SAR620mn tax claim, an unfavourable ruling against Zain KSA in its arbitration process with Mobily and an inability to grow market share and margins, which in turn would threaten capital requirements.

Analyst Certification

We, Abdelrali El Jattari, Ali Dhaloomal, Anton Fedotov, Benjamin Heelan, Celine Fornaro, Faisal AlAzmeh, CFA, Francisco Blanch, Hootan Yazhari, CFA, Jamie Clark, CFA and Jean-Michel Saliba, hereby certify that the views each of us has expressed in this research report accurately reflect each of our respective personal views about the subject securities and issuers. We also certify that no part of our respective compensation was, is, or will be, directly or indirectly, related to the specific recommendations or view expressed in this research report.

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Disclosures

Important Disclosures

Credit opinion history

Bahrain / BHRAIN

Sovereign	Date^	Action	Recommendation
Bahrain / BHRAIN	12-Nov-2015	Initial	Marketweight

Table reflects credit opinion history as of previous business day's close. ^First date of recommendation within last 36 months. The investment opinion system is contained at the end of the report under the heading "BofA Merrill Lynch Credit Opinion Key."

Dubai / DUGB

Sovereign	Date^	Action	Recommendation
Dubai / DUGB	12-Nov-2015	Initial	Marketweight
	08-Jan-2016	Downgrade	Underweight
	28-Apr-2016	Upgrade	Marketweight

Table reflects credit opinion history as of previous business day's close. ^First date of recommendation within last 36 months. The investment opinion system is contained at the end of the report under the heading "BofA Merrill Lynch Credit Opinion Key."

Qatar / QATAR

Sovereign	Date^	Action	Recommendation
Qatar / QATAR	12-Nov-2015	Initial	Marketweight
	08-Jan-2016	Downgrade	Underweight
	26-Feb-2016	Upgrade	Marketweight
	25-May-2016	Restricted	NA

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Buy	5	12.82%	Buy	2	40.00%
Hold	28	71.79%	Hold	12	42.86%
Sell	6	15.38%	Sell	6	100.00%

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Investment rating	Total return expectation (within 12-month period of date of initial rating)	Ratings dispersion guidelines for coverage cluster*
Buy	≥ 10%	≤ 70%
Neutral	≥ 0%	≤ 30%
Underperform	N/A	≥ 20%

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EXHIBIT 4

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November 6, 2017

The Florida Bar
651 E. Jefferson St.
Tallahassee, FL 32399

Re: *Bar Complaint By Mr. Dershowitz*

Dear Florida Bar:

1. I have been advised of assertions made by Mr. Dershowitz to the Florida Bar concerning attorneys David Boies and Sigrid McCawley. I provide this affidavit at the request of counsel for Mr. Boies and Ms. McCawley in order to provide the Florida Bar with information that I have regarding the accuracy or inaccuracy of those assertions.

Civil Cases Against Epstein and Connections with Mr. Dershowitz

12. While the CVRA case was proceeding, Mr. Edwards and I also represented several of Epstein's victims in civil cases against Epstein. During those civil cases, Mr. Epstein was deposed about others who might have been involved in his sexual abuse of minor girls. Several civil attorneys asked Epstein about Mr. Dershowitz, and Epstein invoked his Fifth Amendment rights rather than answer questions about Dershowitz. Efforts were made to depose Dershowitz on his connections, but they were unsuccessful.

13. It was known at the time that Dershowitz had not only served as Epstein's legal counsel, but was also an extremely close personal friend of Epstein.[8] Household employees of Epstein also placed Dershowitz inside the Epstein mansion during time periods when Epstein was involved in sexually abusing minor girls. For example, household employee Juan Alessi testified under oath that one of the famous visitors who came to the Epstein mansion was "a very famous lawyer that I'm sure you know, Alan Dershowitz." (Alessi Depo., at 73:22-25.) According to Alessi's sworn testimony, Dershowitz came to the mansion "pretty often . . . at least four or five times a year" and would stay "two [or] three days." (73:22-25). Alessi also testified that Ms. Virginia Roberts Giuffre came to the house when Dershowitz was there. (73:18-20) Alessi answered "yes" when asked whether Dershowitz "had massages sometimes when he was there," (74:1-4). Alessi explained that "[a] massage was like a treat for everybody." (*Id.*)

14. Similar testimony was provided by another household employee, who worked for Epstein at a different time period -- Alfredo Rodriguez. According to Rodriguez, Dershowitz was at Epstein's mansion when underage girls were there to give massages. (Rodriguez Depo. at 78:13-25, 279:9-280:2). According to Rodriguez, Dershowitz stayed at the house in his role as Epstein's friend, as opposed to being his lawyer. (*Id.* at 279:5-8; 385:1-6).

15. Dershowitz was present alone, without his family, at the home of Jeffery Epstein in the presence of young girls. (*Id.* at 199:12-13, 279:9-12, 426:16-25, 427:1). Rodriguez testified that when the underage girls would come over, Dershowitz would drink wine and read books on the couch. (*Id.* at 426:16-25; 427:1.)

16. Ultimately Epstein choose to settle his civil suits with Jane Doe 1, Jane Doe 2, and Ms. Virginia Roberts Giuffre. However, Epstein did not settle the CVRA case, and Mr. Edwards and I have continued to attempt to secure factual evidence that would demonstrate that the plea decisions made by the Government were improper or improperly influenced.

---

[8] *See, e.g.*, Vicky Ward, *The Talented Mr. Epstein*, in *Vanity Fair* (Jan. 2005) (quoting Dershowitz as stating "I'm on my 20th book. . . . The only person outside of my immediate family that I send drafts to is Jeffrey."); *see also* Ray Gustini, *Vanity Fair Reminds Us When Jeffrey Epstein Wasn't a Creep*, in *The Wire* (June 21, 2011) (quoting Dershowitz as stating that even if Epstein went bankrupt, "I would be as interested in him as a friend if we had hamburgers on the boardwalk in Coney Island and talked about his ideas.").

(Excerpts)

Ms. Virginia Roberts Giuffre as a Witness in the Crime Victims Rights Act Case

17. One witness who became available to Mr. Edwards and me in the CVRA case was Ms. Virginia Roberts Giuffre. She had previously fled to Australia to escape from Mr. Epstein's sexual abuse. But at some point, in around spring 2014, we learned that she was in the United States and was willing to provide testimony in our CVRA case.

18. Because the CVRA case continues to be litigated today, nothing in this affidavit is intended to disclose – nor does it disclose – any confidential communications we received from Ms. Giuffre. However, I can report that in approximately May, 2014, I flew from Utah to Fort Lauderdale, Florida, where Mr. Edwards and I conducted a full-day interview of Ms. Giuffre to learn what evidence she had and to determine whether it was credible.

19. Without going into specific lawyer-client communications that we had with our client, Mr. Edwards and I determined that Ms. Giuffre's allegations of having been sexually abused by Epstein were credible. Ms. Giuffre also said that she had been sexually abused by Mr. Dershowitz. Mr. Edwards and I determined, based on that interview and subsequent careful follow-up, that her allegations were credible and were relevant to our allegations of improper influences affecting the Epstein plea negotiations.

20. Ms. Giuffre also credibly alleged that she had been sexually abused by other rich and powerful friends of Epstein. It appears that she had civil claims that she could file against Epstein's friends. However, because I am law professor with limited litigation resources, I recommended to Mr. Edwards that we should attempt to locate additional litigation support before pursuing lawsuits against abusers who could be expected to marshal considerable financial and other resources in response.

21. Mr. Edwards agreed and ultimately discussed the civil cases with Mr. David Boies, the name partner in the New York-based law firm of Boies Schiller Flexner LLP. I was aware that Mr. Boies not only had a well-regarded large litigation firm, but also had a strong track record of providing legal services for legal cases that might not otherwise attract attention from civil law firms (including cases involving sex trafficking victims).

22. I thought Mr. Boies was an excellent choice to help represent Ms. Giuffre. It is my understanding that Mr. Edwards conveyed to Mr. Boies – as well as, at some point, to his law partner Sigrid McCawley – that I had personally interviewed Ms. Giuffre, had investigated her allegations against Dershowitz and others, and had found them to be credible.

23. Because the CVRA revolved primarily around criminal law issues – an area where both Mr. Edwards and I had considerable experience – we did not require any assistance from Mr. Boies in the CVRA case and we did not approach him about assisting in that case. In 2014, we had successfully handled the CVRA case for more than six years, winning multiple motions without needing outside assistance, and anticipated no need for further help.

Filing Ms. Giuffre's Allegations and Dershowitz's Attacks

24. After more than six months of follow-up investigation, on December 30, 2014, Mr. Edwards and I filed Ms. Virginia Giuffre's allegations of abuse by Epstein, Dershowitz, and others in the CVRA case as part of a motion for her to join the CVRA case. The decision to file was made by Mr. Edwards and me. To the best of my recollection, I did not inform Mr. Boies of our intentions and, to my knowledge, neither he, nor his partner Ms. McCawley, nor attorney Stan Pottinger, were informed in advance of the date or contents of the filing.

33. In the course of those public attacks, Mr. Dershowitz made a number of statements to the press that were inconsistent with information that I possessed.

34. Dershowitz said, for example, that his wife accompanied him everywhere: "I've been married to the same woman for 28 years. She goes with me everywhere. People know that I won't argue a case or give a speech unless my wife travels with me." (*American Lawyer*, Jan. 15, 2015.) Dershowitz also denied being with Epstein in the company of young women: "I was never alone with Jeffrey Epstein in the company of any young women. I can tell you that unequivocally." (*Wall Street Journal*, Jan. 2, 2015). He cited flight manifests: "As far as the planes are concerned, there are flight manifests. They will prove I was never on any private airplane with any young women." (*Hala Gorani, CNN Live*, Jan. 5, 2015).

35. Contrary to these assertions, evidence I possessed showed the following things.

36. On February 9, 1998, Alan Dershowitz appears on flight #1073 to Teterboro Airport with Epstein, Ghislaine Maxwell, Emmy Taylor, Claire Hazel, Joel Pashcow, one unidentified female, Mandy and Dubins +1 (without his wife).

FEB 2	"	"	PBI	TEB		1071	JE, SOPHIE BEDOLE		1/1
6	"	"	TEB	PBI		1072	JE, GM, CT, SOPHIE BEDOLE, EVA, CLAIRE HAZELL, GHISLAINE MAXWELL		
9	"	"	PBI	TEB		1073	JE, GM, EV, CLAIRE HAZEL, JOEL PASHCOW, UNKNOWN, ALAN DERSHOWITZ, MANDY, 1 DUBINS		1/1
12	"	"							1/

37. On February 5, 2004, Alan Dershowitz appears on flight #1695 to Teterboro Airport, then boards flight #1696 to Palm Beach with Epstein and Sarah Kellen (without his wife).

FEB 2	"	"	TIST	TEB		1695	JE, AT, SLA, JM, TD, SK, ALAN DERSHOWITZ	LV	1/
5	"	"	TEB	BED		1696		LV	
5	"	"	BED	TEB		1695		LV	
5	"	"	TED	PBI		1696	JE, AD, SK	LV	

38. On November 17, 2005, Alan Dershowitz appears on flight #1841 to Montreal, Canada, then boards flight #1842 to Bedford, then #1843 to Teterboro with Epstein, Adriana Mucinska (AM), and Tatianna Kovylskna (without his wife).

2005 NOV 12	G-1589B	N405LE	TEB	TIST		1695	JE, ANDREW MOUNTBATTEN WINDSOR, JM, AD, ALAN DERSHOWITZ	LV	
16	"	"	TIST	TEB		1839	JE, AD, JM	LV	
17	"	"	TEB	BED		1840	JE, AT, AM	LV	1/1
17	"	"	BED	CYUL		1841	ALAN DERSHOWITZ	LV	1/1
17	"	"	CYUL	BED		1842	ALAN DERSHOWITZ	LV	
17	"	"	BED	TEB		1843	JE, AM, AD, TATIANNA	LV	

39. To be clear, the flight logs that I had reviewed did not show Mr. Dershowitz alone with Ms. Giuffre. But I did not have a complete set of flight logs for the relevant time period and, in addition, it appears that Mr. Dershowitz had access to the flight logs before they were produced to law enforcement authorities. (*See* Police Detective Joe Recarey Depo. at 281, *Jane Doe No. 2 v. Epstein*, No. 9:08-cv-80119-KAM (Mar. 19, 2010) (Dershowitz personally provided the flight logs).)

40. To also be clear, the foregoing is not a complete recitation of the substantial information that I had that contradicted Mr. Dershowitz's claims.

43. During the lawsuit, Mr. Edwards and I realized that Ms. Giuffre would need separate legal counsel, apart from us, when she became a witness. As a result, we requested and helped to arrange for Ms. McCawley to provide that separate representation.

44. I recall that at some point during the lawsuit, Mr. Dershowitz met with Mr. Boies in an effort to persuade Mr. Boies of his innocence of abusing Ms. Giuffre. While I was not present at that meeting, it was my understanding from later events that Mr. Boies did not find Dershowitz's claims of innocence to be persuasive, particularly given that Dershowitz repeatedly made statements that were demonstrably untrue and apparently deliberate lies.

45. Ultimately, Mr. Edwards and I agreed to settle our defamation lawsuit against Mr. Dershowitz. The terms of the settlement were confidential and nothing in this affidavit should be construed as any disclosing confidential terms of that settlement.

46. That said, I can report that, contemporaneously with settling the case, my attorney, Jack Scarola, filed a Notice of Withdrawal of Motion for Partial Summary Judgment in which he responded to a public distortion made prominently by Mr. Dershowitz. Mr. Dershowitz claimed publicly that the word "mistake," contained in a jointly agreed public statement issued by him and us at the time of settlement, showed that we had supposedly exonerated him of the charges made by our client, Ms. Giuffre. To help keep the record from being distorted, Mr. Scarola included the following accurate statement:

> In the event that the noticed withdrawal is determined to be subject to Court approval, the Plaintiffs would show in support of this notice that Edwards and Cassell continue to represent Virginia Giuffre in separate pending matters, and shall continue to advance her legitimate legal interests in those matters. As expressly understood by the parties upon the execution of the Confidential Settlement Agreement and Mutual Release, Ms. Giuffre reaffirms her allegations, and the withdrawal of the referenced filings is not intended to be, and should not be construed as being, an acknowledgement by Edwards and Cassell that the allegations made by Ms. Giuffre were mistaken. Edwards and Cassell do acknowledge that the public filing in the Crime Victims' Rights Act case of their client's allegations against Defendant Dershowitz became a major distraction from the merits of the well-founded Crime Victims' Rights Act case by causing delay and, as a consequence, turned out to have been a tactical mistake. For that reason, Edwards and Cassell have chosen to withdraw the referenced filing as a condition of settlement.

Notice of Withdrawal of Motion for Partial Summary Judgment, *Edwards & Cassell v. Dershowitz*, No. 15-000072 (17th Judicial Circuit for Broward County, Florida) (Apr. 8, 2016).

No Extortion Plot Exists

53. I understand that Mr. Dershowitz has alleged that, in around fall 2014, Mr. Boies and Ms. McCawley were involved in an "extortion plot" to obtain money from Mr. Wexner. I am not aware of any such plot or even any suggestion of such a plot. I would also find any such suggestion entirely at odds with the professionalism that I have seen exhibited by Mr. Boies and Ms. McCawley in the course of professional dealings with them, including working closely with them as co-counsel to represent Ms. Giuffre in the complicated *Giuffre v. Maxwell* case. At all times they have exhibited nothing but the highest levels of professionalism and adherence to ethical requirements.

54. I expected no less since I knew that Mr. Boies had served as legal counsel in many high profile cases before I had the chance to work with him, including representing the Vice President of the United States before the United States Supreme Court in *Bush v. Gore*. And

while I did not know Ms. McCawley before our contact in this case, I have since learned of her tremendous devotion to her clients and her admirable motivation to insure that victims of sexual abuse receive effective legal representation when attacks on their credibility are made.

Conclusion

55. In light of all these facts, I believe that Mr. Dershowitz's bar complaint against Mr. Boies and Ms. McCawley is frivolous. The foregoing statements are my personal statements and are not an institutional position of the University of Utah. I request that this information be treated confidentially by the Florida Bar and not disseminated outside of the Bar (and those involved in this proceeding) in order to avoid any argument that I have somehow defamed anyone.

I declare that the foregoing statements are all true the best of my information and belief, and I make these statements under penalty of perjury.

Sincerely,

Paul G. Cassell, Esq.

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From: Richard Kahn [redacted]
Sent: 5/9/2018 1:51:01 AM
To: Jeffrey Epstein [jeevacation@gmail.com]
Subject: AT&T confirms it paid Trump lawyer Michael Cohen for 'insights' on administration

Importance: High

https://www.cnbc.com/2018/05/08/att-confirms-it-paid-trump-lawyer-michael-cohen-for-insights-on-administration.html

AT&T confirms it paid Trump lawyer Michael Cohen for 'insights' on administration

11:57 AM ET Fri, 4 May 2018 | 01:18

Getty Images

Michael Cohen, longtime personal lawyer and confidante for President Donald Trump, arrives at the United States District Court Southern District of New York on April 26, 2018 in New York City.

Telecommunications giant AT&T said Tuesday night that it had paid President Donald Trump's lawyer Michael Cohen for "insights" about the Trump administration.

AT&T's admission came after a lawyer for porn star Stormy Daniels claimed the company, drug giant Novartis and a Russian oligarch had all made payments to Cohen's shell company.

Daniels' lawyer, Michael Avenatti, said AT&T had made four separate payments of $50,000 apiece to Cohen's company, for a total of $200,000 in late 2017 and into early 2018.

That company, Essential Consultants, was created by Cohen in October 2016 and soon after was used to make a $130,000 hush-money payment to Daniels.

In a prepared statement to CNBC, AT&T said Cohen's company "was one of several firms we engaged in early 2017 to provide insights into understanding the new administration."

"They did no legal or lobbying work for us, and the contract ended in December 2017," AT&T said.

The company did not say how much it had paid Cohen, who was the president's personal lawyer at the time.

AT&T is in the midst of pursuing an $85 billion acquisition of Time Warner. The U.S. Justice Department has sued to block that deal.

In a report on Cohen's company, Avenatti's law firm said that Novartis in late 2017 and early 2018 made four separate payments to Essential Consultants totaling nearly $400,000.

"Following these payments, reports surfaced that Mr. Trump took a dinner with the incoming CEO of Novartis before Mr. Trump's speech at the World Economic Forum in Davos, Switzerland in late January 2018," Avenatti's report said.

That CEO, Vas Narasimhan, was joined with a group of other companies' executives at that dinner.

A Novartis spokesperson said in a statement that "any agreements with Essential Consultants were entered before our current CEO taking office in February of this year and have expired."

Avenatti's report says another company, Korea Aerospace Industries LTD, paid Essential Consultants $150,000 in November 2017.

Avenatti's client Daniels, whose real name is Stephanie Clifford, was paid $130,000 by Essential Consultants on the eve of the 2016 presidential election.

Daniels says the money was in exchange for her signing a deal that required her to remain silent about an affair she claims to have had with Trump in 2006, shortly after the birth of his youngest son.

The White House has denied that Trump had sex with the adult film actress.

Neither the White House nor Cohen had an immediate comment on Avenatti's new allegations about payments to Cohen's company.

WATCH: Feds saw log of Cohen's phone calls

Richard Kahn
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Penguin Press

National Pub date: February 19, 2019
Title: *DEEP THINKING*
Subtitle: *Twenty-Five Ways of Looking at AI*
By: John Brockman
Length: 90,000 words

Headline: Science world luminary John Brockman assembles twenty-five of the most important scientific minds, people who have been thinking about the field artificial intelligence for most of their careers for an unparalleled round-table examination about mind, thinking, intelligence and what it means to be human.

Description:

"Artificial intelligence is today's story—the story behind all other stories. It is the Second Coming and the Apocalypse at the same time: Good AI versus evil AI." —John Brockman

More than sixty years ago, mathematician-philosopher Norbert Wiener published a book on the place of machines in society that ended with a warning: "we shall never receive the right answers to our questions unless we ask the right questions…. The hour is very late, and the choice of good and evil knocks at our door."

In the wake of advances in unsupervised, self-improving machine learning, a small but influential community of thinkers is considering Wiener's words again. In *Deep Thinking*, John Brockman gathers their disparate visions of where AI might be taking us.

The fruit of the long history of Brockman's profound engagement with the most important scientific minds who have been thinking about AI—from Alison Gopnik and David Deutsch to Frank Wilczek and Stephen Wolfram— *Deep Thinking* is an ideal introduction to the landscape of crucial issues AI presents.

The collision between opposing perspectives is salutary and exhilarating; some of these figures, such as computer scientist Stuart Russell, Skype co-founder Jaan Tallinn, and physicist Max Tegmark, are deeply concerned with the threat of AI, including the existential one, while others, notably robotics entrepreneur Rodney Brooks, philosopher Daniel Dennett, and bestselling author Steven Pinker, have a very different view. Serious, searching and authoritative, *Deep Thinking* lays out the intellectual landscape of one of the most important topics of our time.

Participants in The Deep Thinking Project

Chris Anderson is an entrepreneur; a roboticist; former editor-in-chief of *Wired*; co-founder and CEO of 3DR; and author of *The Long Tail, Free,* and *Makers.*

Rodney Brooks is a computer scientist; Panasonic Professor of Robotics, emeritus, MIT; former director, MIT Computer Science Lab; and founder, chairman, and CTO of Rethink Robotics. He is the author of *Flesh and Machines.*

George M. Church is Robert Winthrop Professor of Genetics at Harvard Medical School; Professor of Health Sciences and Technology, Harvard-MIT; and co-author (with Ed Regis) of *Regenesis: How Synthetic Biology Will Reinvent Nature and Ourselves.*

Daniel C. Dennett is University Professor and Austin B. Fletcher Professor of Philosophy and director of the Center for Cognitive Studies at Tufts University. He is the author of a dozen books, including *Consciousness Explained* and, most recently, From *Bacteria to Bach and Back: The Evolution of Minds.*

David Deutsch is a quantum physicist and a member of the Centre for Quantum Computation at the Clarendon Laboratory, Oxford University. He is the author of *The Fabric of Reality* and *The Beginning of Infinity.*

Anca Dragan is an assistant professor in the Department of Electrical Engineering and Computer Sciences at UC Berkeley. She co-founded and serves on the steering committee for the Berkeley AI Research (BAIR) Lab and is a co-principal investigator in Berkeley's Center for Human-Compatible AI.

George Dyson is a historian of science and technology and the author of *Baidarka: the Kayak, Darwin Among the Machines, Project Orion,* and *Turing's Cathedral.*

Peter Galison is a science historian, Joseph Pellegrino University Professor and co-founder of
the Black Hole Initiative at Harvard University, and the author of *Einstein's Clocks and Poincaré's Maps: Empires of Time.*

Neil Gershenfeld is a physicist and director of MIT's Center for Bits and Atoms. He is the author of *FAB*, co-author (with Alan Gershenfeld & Joel Cutcher-Gershenfeld) of *Designing Reality*, and founder of the global fab lab network.

Alison Gopnik is a developmental psychologist at UC Berkeley; her books include The Philosophical Baby and, most recently, *The Gardener and the Carpenter: What the New Science of Child Development Tells Us About the Relationship Between Parents and Children.*

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Tom Griffiths is Henry R. Luce Professor of Information, Technology, Consciousness, and Culture at Princeton University. He is co-author (with Brian Christian) of *Algorithms to Live By.*

W. Daniel "Danny" Hillis is an inventor, entrepreneur, and computer scientist, Judge Widney Professor of Engineering and Medicine at USC, and author of *The Pattern on the Stone: The Simple Ideas That Make Computers Work.*

Caroline A. Jones is a professor of art history in the Department of Architecture at MIT and author of *Eyesight Alone: Clement Greenberg's Modernism and the Bureaucratization of the Senses; Machine in the Studio: Constructing the Postwar American Artist;* and *The Global Work of Art.*

David Kaiser is Germeshausen Professor of the History of Science and professor of physics at MIT, and head of its Program in Science, Technology & Society. He is the author of *How the Hippies Saved Physics: Science, Counterculture*, and the *Quantum Revival and American Physics and the Cold War Bubble* (forthcoming).

Seth Lloyd is a theoretical physicist at MIT, Nam P. Suh Professor in the Department of Mechanical Engineering, and an external professor at the Santa Fe Institute. He is the author of *Programming the Universe: A Quantum Computer Scientist Takes on the Cosmos.*

Hans Ulrich Obrist is artistic director of the Serpentine Gallery, London, and the author of *Ways of Curating* and *Lives of the Artists, Lives of the Architects.*

Judea Pearl is professor of computer science and director of the Cognitive Systems Laboratory at UCLA. His most recent book, co-authored with Dana Mackenzie, is *The Book of Why: The*

Alex "Sandy" Pentland is Toshiba Professor and professor of media arts and sciences, MIT; director of the Human Dynamics and Connection Science labs and the Media Lab Entrepreneurship Program, and the author of *Social Physics.*
New Science of Cause and Effect.

Steven Pinker, a Johnstone Family Professor in the Department of Psychology at Harvard University, is an experimental psychologist who conducts research in visual cognition, psycholinguistics, and social relations. He is the author of eleven books, including *The Blank Slate, The Better Angels of Our Nature*, and, most recently, *Enlightenment Now: The Case for Reason, Science, Humanism, and Progress.*

Venki Ramakrishnan is a scientist at the Medical Research Council Laboratory of Molecular Biology, Cambridge University; recipient of the Nobel Prize in Chemistry (2009); current president of the Royal Society; and the author of *Gene Machine: The Race to Discover the Secrets of the Ribosome.*

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Stuart Russell is a professor of computer science and Smith-Zadeh Professor in Engineering at UC Berkeley. He is the coauthor (with Peter Norvig) of *Artificial Intelligence: A Modern Approach.*

Jaan Tallin, a computer programmer, theoretical physicist, and investor, is a co-developer of Skype and Kazaa.

Max Tegmark is an MIT physicist and AI researcher; president of the Future of Life Institute; scientific director of the Foundational Questions Institute; and the author of *Our Mathematical Universe* and *Life 3.0: Being Human in the Age of Artificial Intelligence.*

Frank Wilczek is Herman Feshbach Professor of Physics at MIT, recipient of the 2004 Nobel Prize in physics, and the author of *A Beautiful Question: Finding Nature's Deep Design*.

Stephen Wolfram is a scientist, inventor, and the founder and CEO of Wolfram Research. He is the creator of the symbolic computation program Mathematica and its programming language, Wolfram Language, as well as the knowledge engine Wolfram|Alpha. He is also the author of *A New Kind of Science.*

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Deep Thinking
Twenty-five Ways of Looking at AI

edited by John Brockma

Penguin Press — February 19, 2019

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by John Brockman
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What quickly emerged from that first meeting is that the excitement and fear in the wider culture surrounding AI now has an analogue in the way Norbert Wiener's ideas regarding "cybernetics" worked their way through the culture, particularly in the 1960's, as artists began to incorporate thinking about new technologies into their work. I witnessed the impact of those ideas at close hand; indeed it's not too much to say they set me off on my life's path. With the advent of the digital era beginning in the early 1970s, people stopped talking about Wiener, but today, his Cybernetic Idea has been so widely adopted that it's internalized to the point where it no longer needs a name. It's everywhere, it's in the air, and it's a fitting a place to begin.

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Introduction: On the Promise and Peril of AI
John Brockman

Artificial intelligence is today's story—the story behind all other stories. It is the Second Coming and the Apocalypse at the same time: Good AI versus evil AI. This book comes out of an ongoing conversation with a number of important thinkers, both in the world of AI and beyond it, about what AI is and what it means. Called the Deep Thinking Project, this conversation began in earnest in September 2016, in a meeting at the Mayflower Grace Hotel in Washington, Connecticut with some of the book's contributors.

What quickly emerged from that first meeting is that the excitement and fear in the wider culture surrounding AI now has an analogue in the way Norbert Wiener's ideas regarding "cybernetics" worked their way through the culture, particularly in the 1960's, as artists began to incorporate thinking about new technologies into their work. I witnessed the impact of those ideas at close hand; indeed it's not too much to say they set me off on my life's path. With the advent of the digital era beginning in the early 1970s, people stopped talking about Wiener, but today, his Cybernetic Idea has been so widely adopted that it's internalized to the point where it no longer needs a name. It's everywhere, it's in the air, and it's a fitting a place to begin.

New Technologies=New Perceptions

Before AI, there was Cybernetics—the idea of automatic, self-regulating control, laid out in Norbert Wiener's foundational text of 1948. I can date my own serious exposure to it to 1966, when the composer John Cage invited me and four or five other young arts people to join him for a series of dinners—an ongoing seminar about media, communications, art, music, and philosophy that focused on Cage's interest in the ideas of Wiener, Claude Shannon, and Marshall McLuhan, all of whom had currency in the New York art circles in which I was then moving. In particular, Cage had picked up on McLuhan's idea that by inventing electronic technologies we had externalized our central nervous system—that is, our minds—and that we now had to presume that "there's only one mind, the one we all share."

Ideas of this nature were beginning to be of great interest to the artists I was working with in New York at the Film-Makers' Cinémathèque, where I was program manager for a series of multimedia productions called the New Cinema 1 (also known as the Expanded Cinema Festival), under the auspices of avant-garde filmmaker and impresario Jonas Mekas. They included visual artists Claes Oldenburg, Robert Rauschenberg, Andy Warhol, Robert Whitman; kinetic artists Charlotte Moorman and Nam June Paik; happenings artists Allan Kaprow and Carolee Schneemann; dancer Tricia Brown; filmmakers Jack Smith, Stan Vanderbeek, Ed Emshwiller, and the Kuchar brothers; avant-garde dramatist Ken Dewey; poet Gerd Stern and the USCO group; minimalist musicians Lamonte Young and Terry Riley; and through Warhol, the music group, The Velvet Underground. Many of these people were reading Wiener, and cybernetics was in the air. It was at one of these dinners that Cage reached into his briefcase and took out a copy of *Cybernetics* and handed it to me, saying, "This is for you."

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During the Festival, I received an unexpected phone call from Wiener's colleague Arthur K. Solomon, head of Harvard's graduate program in biophysics. Wiener had died the year before, and Solomon and Wiener's other close colleagues at MIT and Harvard had been reading about the Expanded Cinema Festival in the *New York Times* and were intrigued by the connection to Wiener's work. Solomon invited me to bring some of the artists up to Cambridge to meet with him and a group that included MIT sensory-communications researcher Walter Rosenblith, Harvard applied mathematician Anthony Oettinger, and MIT engineer Harold "Doc" Edgerton, inventor of the strobe light.

Like many other "art meets science" situations I've been involved in since, the two-day event was an informed failure: ships passing in the night. But I took it all onboard and the event was consequential in some interesting ways—one of which came from the fact that they took us to see "the" computer. Computers were a rarity back then; at least, none of us on the visit had ever seen one. We were ushered into a large space on the MIT campus, in the middle of which there was a "cold room" raised off the floor and enclosed in glass, in which technicians wearing white lab coats, scarves, and gloves were busy collating punch cards coming through an enormous machine. When I approached, the steam from my breath fogged up the window into the cold room. Wiping it off, I saw "the" computer. I fell in love.

Later, in the Fall of 1967, I went to Menlo Park to spend time with Stewart Brand, whom I had met in New York in 1965 when he was a satellite member of the USCO group of artists. Now, with his wife Lois, a mathematician, he was preparing the first edition of *The Whole Earth Catalog* for publication. While Lois and the team did the heavy lifting on the final mechanicals for WEC, Stewart and I sat together in a corner for two days, reading, underlining, and annotating the same paperback copy of *Cybernetics* that Cage had handed to me the year before, and debating Wiener's ideas.

Inspired by this set of ideas, I began to develop a theme, a mantra of sorts, that has informed my endeavors since: "new technologies = new perceptions." Inspired by communications theorist Marshall McLuhan, architect-designer Buckminster Fuller, futurist John McHale, and cultural anthropologists Edward T. (Ned) Hall and Edmund Carpenter, I started reading avidly in the field of information theory, cybernetics, and systems theory. McLuhan suggested I read biologist J.Z. Young's *Doubt and Certainty in Science* in which he said that we create tools and we mold ourselves through our use of them. The other text he recommended was Warren Weaver and Claude Shannon's 1949 paper "Recent Contributions to the Mathematical Theory of Communication," which begins: "The word *communication* will be used here in a very broad sense to include all of the procedures by which one mind may affect another. This, of course, involves not only written and oral speech, but also music, the pictorial arts, the theater, the ballet, and in fact all human behavior."

Who knew that within two decades of that moment we would begin to recognize the brain as a computer? And in the next two decades, as we built our computers into the Internet, that we would begin to realize that the brain is not a computer, but a network of computers? Certainly not Wiener, a specialist in analogue feedback circuits designed to control machines, nor the artists, nor, least of all, myself.

"We must cease to kiss the whip that lashes us."

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Two years after *Cybernetics,* in 1950, Norbert Wiener published *The Human Use of Human Beings*—a deeper story, in which he expressed his concerns about the runaway commercial exploitation and other unforeseen consequences of the new technologies of control. I didn't read *The Human Use of Human Beings* until the spring of 2016, when I picked up my copy, a first edition, which was sitting in my library next to *Cybernetics.* What shocked me was the realization of just how prescient Wiener was in 1950 about what's going on today. Although the first edition was a major bestseller—and, indeed, jump-started an important conversation—under pressure from his peers Wiener brought out a revised and milder edition in 1954, from which the original concluding chapter, "Voices of Rigidity," is conspicuously absent.

Science historian George Dyson points out that in this long-forgotten first edition, Wiener predicted the possibility of a "threatening new Fascism dependent on the *machine à gouverner*":

> No elite escaped his criticism, from the Marxists and the Jesuits ("all of Catholicism is indeed essentially a totalitarian religion") to the FBI ("our great merchant princes have looked upon the propaganda technique of the Russians, and have found that it is good") and the financiers lending their support "to make American capitalism and the fifth freedom of the businessman supreme throughout the world." Scientists . . . received the same scrutiny given the Church: "Indeed, the heads of great laboratories are very much like Bishops, with their association with the powerful in all walks of life, and the dangers they incur of the carnal sins of pride and of lust for power."

This jeremiad did not go well for Wiener. As Dyson puts it:

> These alarms were discounted at the time, not because Wiener was wrong about digital computing but because larger threats were looming as he completed his manuscript in the fall of 1949. Wiener had nothing against digital computing but was strongly opposed to nuclear weapons and refused to join those who were building digital computers to move forward on the thousand-times-more-powerful hydrogen bomb.

Since the original of *The Human Use of Human Beings* is now out of print, lost to us is Wiener's *cri de coeur*, more relevant today than when he wrote it, sixty-eight years ago: "We must cease to kiss the whip that lashes us."

Mind, Thinking, Intelligence

Among the reasons we don't hear much about "Cybernetics" today, two are central: First, although *The Human Use of Human Beings* was considered an important book in its time, it ran counter to the aspirations of many of Wiener's colleagues, including John von Neumann and Claude Shannon, who were interested in the commercialization of the new technologies. Second, computer pioneer John McCarthy disliked Wiener and refused to use Wiener's term "Cybernetics." McCarthy, in turn, coined the term "artificial intelligence" and became a founding father of that field.

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As Judea Pearl, who, in the 1980s, introduced a new approach to artificial intelligence called Bayesian networks, explained to me:

> What Wiener created was excitement to believe that one day we are going to make an intelligent machine. He wasn't a computer scientist. He talked feedback, he talked communication, he talked analog. His working metaphor was a feedback circuit, which he was an expert in. By the time the digital age began in the early 1960s people wanted to talk programming, talk codes, talk about computational functions, talk about short-term memory, long-term memory—meaningful computer metaphors. Wiener wasn't part of that, and he didn't reach the new generation that germinated with his ideas. His metaphors were too old, *passé*. There were new means already available that were ready to capture the human imagination." By 1970, people were no longer talking about Wiener.

One critical factor missing in Wiener's vision was the cognitive element: mind, thinking, intelligence. As early as 1942, at the first of a series of foundational interdisciplinary meetings about the control of complex systems that would come to be known as the Macy conferences, leading researchers were arguing for the inclusion of the cognitive element into the conversation. While von Neumann, Shannon, and Wiener were concerned about systems of control and communication of observed systems, Warren McCullough wanted to include mind. He turned to cultural anthropologists Gregory Bateson and Margaret Mead to make the connection to the social sciences. Bateson in particular was increasingly talking about patterns and processes, or "the pattern that connects." He called for a new kind of systems ecology in which organisms and the environment in which they live are one in the same, and should be considered as a single circuit. By the early 1970s the Cybernetics of observed systems—1st order Cybernetics—moved to the Cybernetics of observing systems—2nd order Cybernetics—or "the Cybernetics of Cybernetics", as coined by Heinz von Foerster, who joined the Macy conferences in the mid 1950s, and spearheaded the new movement.

Cybernetics, rather than disappearing, was becoming metabolized into *everything*, so we no longer saw it as a separate, distinct new discipline. And there it remains, hiding in plain sight.

"The Shtick of the Steins"

My own writing about these issues at the time was on the radar screen of the 2nd order Cybernetics crowd, including Heinz von Foerster as well as John Lilly and Alan Watts, who were the co-organizers of something called "The AUM Conference," shorthand for "The American University of Masters", which took place in Big Sur in 1973, a gathering of philosophers, psychologists, and scientists, each of whom asked to lecture on his own work in terms of its relationship to the ideas of British mathematician G. Spencer Brown presented in his book, *Laws of Form*.

I was a bit puzzled when I received an invitation—a very late invitation indeed—which they explained was based on their interest in the ideas I presented in a book called *Afterwords*, which were very much on their wavelength. I jumped at the opportunity, the main reason being that the keynote speaker was none other than Richard Feynman. I love

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to spend time with physicists, the reason being that they think about the universe, i.e. everything. And no physicist was reputed to be articulate as Feynman. I couldn't wait to meet him. I accepted. That said, I am not a scientist, and I had never entertained the idea of getting on a stage and delivering a "lecture" of any kind, least of all a commentary on an obscure mathematical theory in front of a group identified as the world's most interesting thinkers. Only upon my arrival in Big Sur did I find out the reason for my very late invitation. "When is Feynman's talk?" I asked at the desk. "Oh, didn't Alan Watts tell you? Richard is ill and has been hospitalized. You're his replacement. And, by the way, what's the title of your keynote lecture?"

I tried to make myself invisible for several days. Alan Watts, realizing that I was avoiding the podium, woke me up one night with a 3am knock on the door of my room. I opened the door to find him standing in front of me wearing a monk's robe with a hood that covering much of his face. His arms extended, he held a lantern in one hand, and a magnum of scotch on the other.

"John", he said in a deep voice with a rich aristocratic British accent, "you are a phony." "And, John", he continued, I am a phony. But John, I am a *real* phony!"

The next day I gave my lecture, entitled "Einstein, Gertrude Stein, Wittgenstein, and Frankenstein." Einstein: the revolution in 20th century physics; Gertrude Stein: the first writer who made integral to her work the idea of an indeterminate and discontinuous universe. Words represented neither character nor activity: A rose is a rose is a rose, and a universe is a universe is a universe.); Wittgenstein: the world as limits of language. "The limits of my language mean the limits of my world". The end of the distinction between observer and observed. Frankenstein: Cybernetics AI, robotics, all the essayists in this volume.

The lecture had unanticipated consequences. Among the participants at the AUM Conference were several authors of #1 New York Times bestsellers, yet no one there had a literary agent. And I realized that all were engaged in writing a genre of book both unnamed and unrecognized by New York publishers. Since I had an MBA from Colombia Business School, and a series of relative successes in business, I was dragooned into becoming an agent, initially for Gregory Bateson and John Lilly, whose books I sold quickly, and for sums that caught my attention, thus kick-starting my career as a literary agent.

I never did meet Richard Feynman.

The Long AI Winters

This new career put me in close touch with most of the AI pioneers, and over the decades I rode with them on waves of enthusiasm, and into valleys of disappointment.

In the early '80s the Japanese government mounted a national effort to advance AI. They called it the 5th Generation; their goal was to change the architecture of computation by breaking "the von Neumann bottleneck", by creating a massively parallel computer. In so doing, they hoped to jumpstart their economy and become a dominant world power in the field. In1983, the leader of the Japanese 5th Generation consortium came to New York for a meeting organized by Heinz Pagels, the president of the New York Academy of Sciences. I had a seat at the table alongside the leaders of the 1st generation, Marvin Minsky and John McCarthy, the 2nd generation, Edward Feigenbaum

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and Roger Schank, and Joseph Traub, head of the National Supercomputer Consortium.

In 1981 with Heinz's help, I had founded "The Reality Club" (the precursor to the non-profit Edge.org), whose initial interdisciplinary meetings took place in the Board Room at the NYAS. Heinz was working on his book, *Dreams of Reason: The Rise of the Science of Complexity*, which he considered to be a research agenda for science in the 1990's.

Through the Reality Club meetings, I got to know two young researchers who were about to play key roles in revolutionizing computer science. At MIT in the late seventies, Danny Hillis developed the algorithms that made possible the massively parallel computer. In 1983, his company, Thinking Machines, built the world's fastest supercomputer by utilizing parallel architecture. His "connection machine," closely reflected the workings of the human mind. Seth Lloyd at Rockefeller University was undertaking seminal work in the fields of quantum computation and quantum communications, including proposing the first technologically feasible design for a quantum computer.

And the Japanese? Their foray into artificial intelligence failed, and was followed by twenty years of anemic economic growth. But, the leading US scientists took this program very seriously. And Feigenbaum, who was the cutting-edge computer scientist of the day, teamed up with McCorduck to write a book on these developments. *The Fifth Generation: Artificial Intelligence and Japan's Computer Challenge to the World* was published in 1983. We had a code name for the project: "It's coming, it's coming!" But it didn't come; it went.

From that point on I've worked with researchers in nearly every variety of AI and complexity, including Rodney Brooks, Hans Moravec, John Archibald Wheeler, Benoit Mandelbrot, John Henry Holland, Danny Hillis, Freeman Dyson, Chris Langton, Doyne Farmer, Geoffrey West, Stuart Russell, and Judea Pearl.

An Ongoing Dynamical Emergent System

From the initial meeting in Washington, CT to the present, I arranged a number of dinners and discussions in London and Cambridge, Massachusetts, as well as a public event at London's City Hall. Among the attendees were distinguished scientists, science historians, and communications theorists, all of whom have been thinking seriously about AI issues for their entire careers.

I commissioned essays from a wide range of contributors, with or without references to Wiener (leaving it up to each participant). In the end, 25 people wrote essays, all individuals concerned about what is happening today in the age of AI. *Deep Thinking* in not *my* book, rather it is *our* book: Seth Lloyd, Judea Pearl, Stuart Russell, George Dyson, Daniel C. Dennett, Rodney Brooks, Frank Wilczek, Max Tegmark, Jaan Tallinn, Steven Pinker, David Deutsch, Tom Griffiths, Anca Dragan, Chris Anderson, David Kaiser, Neil Gershenfeld, W. Daniel Hillis, Venki Ramakrishnan, Alex "Sandy" Pentland, Hans Ulrich Obrist, Alison Gopnik, Peter Galison, George M. Church, Caroline A. Jones, Stephen Wolfram.

I see The Deep Thinking Project as an ongoing dynamical emergent system, a presentation of the ideas of a community of sophisticated thinkers who are bringing their experience and erudition to bear in challenging the prevailing digital AI narrative as they

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communicate their thoughts to one another. The aim is to present a mosaic of views which will help make sense out of this rapidly emerging field.

I asked the essayists to consider:

(a) The Zen-like poem "Thirteen Ways of Looking at a Blackbird," by Wallace Stevens, which he insisted was "not meant to be a collection of epigrams or of ideas, but of sensations." It is an exercise in "perspectivism," consisting of short, separate sections, each of which mentions blackbirds in some way. The poem is about his own imagination; it concerns what he attends to.

(b) The parable of the blind men and an elephant. Like the elephant, AI is too big a topic for any one perspective, never mind the fact that no two people seem to see things the same way.

What do we want the book to do? Stewart Brand has noted that "revisiting pioneer thinking is perpetually useful. And it gives a long perspective that invites thinking in decades and centuries about the subject. All contemporary discussion, is bound to age badly and immediately without the longer perspective."

Danny Hillis wants people in AI to realize how they've been programmed by Wiener's book. "You're executing its road map," he says, and you just don't realize it."

Dan Dennett would like to "let Wiener emerge as the ghost at the banquet. Think of it as a source of hybrid vigor, a source of unsettling ideas to shake uŒp the established mindset."

Neil Gershenfeld argues that "stealth remedial education for the people running the "Big Five" would be a great output from the book."

Freeman Dyson Freeman, one of the few people alive who knew Wiener, notes that "*The* Human *Use of Human Beings* is one of the best books ever written. Wiener got almost everything right. I will be interested to see what your bunch of wizards will do with it."

The Evolving AI Narrative

Things have changed—and they remain the same. Now AI is everywhere. We have the Internet. We have our smartphones. The founders of the dominant companies—the companies that hold "the whip that lashes us"—have net worths of $65 billion, $90 billion, $130 billion. High-profile individuals such as Elon Musk, Nick Bostrom, Martin Rees, Eliezer Yudkowsky, and the late Stephen Hawking have issued dire warnings about AI, resulting in the ascendancy of well-funded institutes tasked with promoting "Nice AI." But will we, as a species, be able to control a fully realized, unsupervised, self-improving AI? Wiener's warnings and admonitions in *The Human Use of Human Beings* are now very real, and they need to be looked at anew by researchers at the forefront of the AI revolution. Here is Dyson again:

> Wiener became increasingly disenchanted with the "gadget worshipers" whose corporate selfishness brought "motives to automatization that go beyond a legitimate curiosity and are sinful in themselves." He knew the danger was not machines becoming more like humans but humans being treated like machines. "The world of the future will be an ever more demanding struggle against the limitations of our intelligence," he warned in *God & Golem, Inc.*, published in

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1964, the year of his death, "not a comfortable hammock in which we can lie down to be waited upon by our robot slaves."

It's time to examine the evolving AI narrative by identifying the leading members of that mainstream community along with the dissidents, and presenting their counternarratives in their own voices.

The essays that follow thus constitute a much-needed update from the field.

John Brockman
New York, 2019

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I met ***Seth Lloyd*** *in the late 1980s, when new ways of thinking were everywhere: the importance of biological organizing principles, the computational view of mathematics and physical processes, the emphasis on parallel networks, the importance of nonlinear dynamics, the new understanding of chaos, connectionist ideas, neural networks, and parallel distributive processing. The advances in computation during that period provided us with a new way of thinking about knowledge.*

Seth likes to refer to himself as a quantum mechanic. He is internationally known for his work in the field of quantum computation, which attempts to harness the exotic properties of quantum theory, like superposition and entanglement, to solve problems that would take several lifetimes to solve on classical computers.

In the essay that follows, he traces the history of information theory from Norbert Wiener's prophetic insights to the predictions of a technological "singularity" that some would have us believe will supplant the human species. His takeaway on the recent programming method known as deep learning is to call for a more modest set of expectations; he notes that despite AI's enormous advances, robots "still can't tie their own shoes."

It's difficult for me to talk about Seth without referencing his relationship with his friend and professor, the late theoretical physicist Heinz Pagels of Rockefeller University. The graduate student and the professor each had a profound effect on each other's ideas.

In the summer of 1988, I visited Heinz and Seth at the Aspen Center for Physics. Their joint work on the subject of complexity was featured in the current issue of Scientific American*; they were ebullient. That was just two weeks before Heinz's tragic death in a hiking accident while descending Pyramid Peak with Seth. They were talking about quantum computing.*

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WRONG, BUT MORE RELEVANT THAN EVER
Seth Lloyd

Seth Lloyd *is a theoretical physicist at MIT, Nam P. Suh Professor in the Department of Mechanical Engineering, and an external professor at the Santa Fe Institute.*

The Human Use of Human Beings, Norbert Wiener's 1950 popularization of his highly influential book *Cybernetics: Control and Communication in the Animal and the Machine* (1948), investigates the interplay between human beings and machines in a world in which machines are becoming ever more computationally capable and powerful. It is a remarkably prescient book, and remarkably wrong. Written at the height of the Cold War, it contains a chilling reminder of the dangers of totalitarian organizations and societies, and of the danger to democracy when it tries to combat totalitarianism with totalitarianism's own weapons.

Wiener's *Cybernetics* looked in close scientific detail at the process of control via feedback. ("Cybernetics," from the ancient Greek for "helmsman," is the etymological basis of our word "governor," which is what James Watt called his pathbreaking feedback control device that transformed the use of steam engines.) Because he was immersed in problems of control, Wiener saw the world as a set of complex, interlocking feedback loops, in which sensors, signals, and actuators such as engines interact via an intricate exchange of signals and information. The engineering applications of *Cybernetics* were tremendously influential and effective, giving rise to rockets, robots, automated assembly lines, and a host of precision-engineering techniques—in other words, to the basis of contemporary industrial society.

Wiener had greater ambitions for cybernetic concepts, however, and in *The Human Use of Human Beings* he spells out his thoughts on its application to topics as diverse as Maxwell's Demon, human language, the brain, insect metabolism, the legal system, the role of technological innovation in government, and religion. These broader applications of cybernetics were an almost unequivocal failure. Vigorously hyped from the late 1940s to the early 1960s—to a degree similar to the hype of computer and communication technology that led to the dotcom crash of 2000-2001—cybernetics delivered satellites and telephone switching systems but generated few if any useful developments in social organization and society at large.

Nearly seventy years later, however, *The Human Use of Human Beings* has more to teach us humans than it did the first time around. Perhaps the most remarkable feature of the book is that it introduces a large number of topics concerning human/machine interactions that are still of considerable relevance. Dark in tone, the book makes several predictions about disasters to come in the second half of the 20th century, many of which are almost identical to predictions made today about the second half of the 21st.

For example, Wiener foresaw a moment in the near future of 1950 in which humans would cede control of society to a cybernetic artificial intelligence, which would then proceed to wreak havoc on humankind. The automation of manufacturing, Wiener predicted, would both create large advances in productivity and displace many workers from their jobs—a sequence of events that did indeed come to pass in the ensuing decades. Unless society could find productive occupations for these displaced workers, Wiener warned, revolt would ensue.

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But Wiener failed to foresee crucial technological developments. Like pretty much all technologists of the 1950s, he failed to predict the computer revolution. Computers, he thought, would eventually fall in price from hundreds of thousands of (1950s) dollars to tens of thousands; neither he nor his compeers anticipated the tremendous explosion of computer power that would follow the development of the transistor and the integrated circuit. Finally, because of his emphasis on control, Wiener could not foresee a technological world in which innovation and self-organization bubble up from the bottom rather than being imposed from the top.

Focusing on the evils of totalitarianism (political, scientific, and religious), Wiener saw the world in a deeply pessimistic light. His book warned of the catastrophe that awaited us if we didn't mend our ways, fast. The current world of human beings and machines, more than a half century after its publication, is much more complex, richer, and contains a much wider variety of political, social, and scientific systems than he was able to envisage. The warnings of what will happen if we get it wrong, however—for example, control of the entire Internet by a global totalitarian regime—remain as relevant and pressing today as they were in 1950.

What Wiener Got Right

Wiener's most famous mathematical works focused on problems of signal analysis and the effects of noise. During World War II, he developed techniques for aiming anti-aircraft fire by making models that could predict the future trajectory of an airplane by extrapolating from its past behavior. In *Cybernetics* and in *The Human Use of Human Beings*, Wiener notes that this past behavior includes quirks and habits of the human pilot, thus a mechanized device can predict the behavior of humans. Like Alan Turing, whose Turing Test suggested that computing machines could give responses to questions which were indistinguishable from human responses, Wiener was fascinated by the notion of capturing human behavior by mathematical description. In the 1940s, he applied his knowledge of control and feedback loops to neuro-muscular feedback in living systems, and was responsible for bringing Warren McCulloch and Walter Pitts to MIT, where they did their pioneering work on artificial neural networks.

Wiener's central insight was that the world should be understood in terms of information. Complex systems, such as organisms, brains, and human societies, consist of interlocking feedback loops in which signals exchanged between subsystems result in complex but stable behavior. When feedback loops break down, the system goes unstable. He constructed a compelling picture of how complex biological systems function, a picture that is by and large universally accepted today.

Wiener's vision of information as the central quantity in governing the behavior of complex systems was remarkable at the time. Nowadays, when cars and refrigerators are jammed with microprocessors and much of human society revolves around computers and cell phones connected by the Internet, it seems prosaic to emphasize the centrality of information, computation, and communication. In Wiener's time, however, the first digital computers had only just come into existence, and the Internet was not even a twinkle in the technologist's eye.

Wiener's powerful conception of not just engineered complex systems but all complex systems as revolving around cycles of signals and computation led to tremendous contributions to the development of complex human-made systems. The

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methods he and others developed for the control of missiles, for example, were later put to work in building the Saturn V moon rocket, one of the crowning engineering achievements of the 20th century. In particular, Wiener's applications of cybernetic concepts to the brain and to computerized perception are the direct precursors of today's neural-network-based deep-learning circuits, and of artificial intelligence itself. But current developments in these fields have diverged from his vision, and their future development may well affect the human uses both of human beings and of machines.

What Wiener Got Wrong

It is exactly in the extension of the cybernetic idea to human beings that Wiener's conceptions missed their target. Setting aside his ruminations on language, law, and human society for the moment, look at a humbler but potentially useful innovation that he thought was imminent in 1950. Wiener notes that prosthetic limbs would be much more effective if their wearers could communicate directly with their prosthetics by their own neural signals, receiving information about pressure and position from the limb and directing its subsequent motion. This turned out to be a much harder problem than Wiener envisaged: Seventy years down the road, prosthetic limbs that incorporate neural feedback are still in the very early stages. Wiener's concept was an excellent one—it's just that the problem of interfacing neural signals with mechanical-electrical devices is hard.

More significantly, Wiener (along with pretty much everyone else in 1950) greatly underappreciated the potential of digital computation. As noted, Wiener's mathematical contributions were to the analysis of signals and noise and his analytic methods apply to continuously varying, or analog, signals. Although he participated in the wartime development of digital computation, he never foresaw the exponential explosion of computing power brought on by the introduction and progressive miniaturization of semiconductor circuits. This is hardly Wiener's fault: The transistor hadn't been invented yet, and the vacuum-tube technology of the digital computers he was familiar with was clunky, unreliable, and unscalable to ever larger devices. In an appendix to the 1948 edition of *Cybernetics,* he anticipates chess-playing computers and predicts that they'll be able to look two or three moves ahead. He might have been surprised to learn that within half a century a computer would beat the human world champion at chess.

Technological Overestimation and the Existential Risks of the Singularity

When Wiener wrote his books, a significant example of technological overestimation was about to occur. The 1950s saw the first efforts at developing artificial intelligence, by researchers such as Herbert Simon, John McCarthy, and Marvin Minsky, who began to program computers to perform simple tasks and to construct rudimentary robots. The success of these initial efforts inspired Simon to declare that "machines will be capable, within twenty years, of doing any work a man can do." Such predictions turned out to be spectacularly wrong. As they became more powerful, computers got better and better at playing chess because they could systematically generate and evaluate a vast selection of possible future moves. But the majority of predictions of AI, e.g., robotic maids, turned out to be illusory. When Deep Blue beat Garry Kasparov at chess in 1997, the most

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powerful room-cleaning robot was a Roomba, which moved around vacuuming at random and squeaked when it got caught under the couch.

Technological prediction is particularly chancy, given that technologies progress by a series of refinements, halted by obstacles and overcome by innovation. Many obstacles and some innovations can be anticipated, but more cannot. In my own work with experimentalists on building quantum computers, I typically find that some of the technological steps I expect to be easy turn out to be impossible, whereas some of the tasks I imagine to be impossible turn out to be easy. You don't know until you try.

In the 1950s, partly inspired by conversations with Wiener, John von Neumann introduced the notion of the "technological singularity." Technologies tend to improve exponentially, doubling in power or sensitivity over some interval of time. (For example, since 1950, computer technologies have been doubling in power roughly every two years, an observation enshrined as Moore's Law.) Von Neumann extrapolated from the observed exponential rate of technological improvement to predict that "technological progress will become incomprehensively rapid and complicated," outstripping human capabilities in the not too distant future. Indeed, if one extrapolates the growth of raw computing power—expressed in terms of bits and bit flips—into the future at its current rate, computers should match human brains sometime in the next two to four decades (depending on how one estimates the information-processing power of human brains).

The failure of the initial overly optimistic predictions of AI dampened talk about the technological singularity for a few decades, but since the 2005 publication of Ray Kurzweil's *The Singularity is Near,* the idea of technological advance leading to superintelligence is back in force. Some believers, Kurzweil included, regard this singularity as an opportunity: Humans can merge their brains with the superintelligence and thereby live forever. Others, such as Stephen Hawking and Elon Musk, worried that this superintelligence would prove to be malign and regarded it as the greatest existing threat to human civilization. Still others, including some of the contributors to the present volume, think such talk is overblown.

Wiener's life work and his failure to predict its consequences are intimately bound up in the idea of an impending technological singularity. His work on neuroscience and his initial support of McCulloch and Pitts adumbrated the startlingly effective deep-learning methods of the present day. Over the past decade, and particularly in the last five years, such deep-learning techniques have finally exhibited what Wiener liked to call *Gestalt*—for example, the ability to recognize that a circle is a circle even if when slanted sideways it looks like an ellipse. His work on control, combined with his work on neuromuscular feedback, was significant for the development of robotics and is the inspiration for neural-based human/machine interfaces. His lapses in technological prediction, however, suggest that we should take the notion of a technological singularity with a grain of salt. The general difficulties of technological prediction and the problems specific to the development of a superintelligence should warn us against overestimating both the power and the efficacy of information processing.

The Arguments for Singularity Skepticism

No exponential increase lasts forever. An atomic explosion grows exponentially, but

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only until it runs out of fuel. Similarly, the exponential advances in Moore's Law are starting to run into limits imposed by basic physics. The clock speed of computers maxed out at a few gigahertz a decade and a half ago, simply because the chips were starting to melt. The miniaturization of transistors is already running into quantum-mechanical problems due to tunneling and leakage currents. Eventually, the various exponential improvements in memory and processing driven by Moore's Law will grind to a halt. A few more decades, however, will probably be time enough for the raw information-processing power of computers to match that of brains—at least by the crude measures of number of bits and number of bit-flips per second.

Human brains are intricately constructed, the process of millions of years of natural selection. In Wiener's time, our understanding of the architecture of the brain was rudimentary and simplistic. Since then, increasingly sensitive instrumentation and imaging techniques have shown our brains to be far more varied in structure and complex in function than Wiener could have imagined. I recently asked Tomaso Poggio, one of the pioneers of modern neuroscience, whether he was worried that computers, with their rapidly increasing processing power, would soon emulate the functioning of the human brain. "Not a chance," he replied.

The recent advances in deep learning and neuromorphic computation are very good at reproducing a particular aspect of human intelligence focused on the operation of the brain's cortex, where patterns are processed and recognized. These advances have enabled a computer to beat the world champion not just of chess but of Go, an impressive feat, but they're far short of enabling a computerized robot to tidy a room. (In fact, robots with anything approaching human capability in a broad range of flexible movements are still far away—search "robots falling down." Robots are good at making precision welds on assembly lines, but they still can't tie their own shoes.)

Raw information-processing power does not mean sophisticated information-processing power. While computer power has advanced exponentially, the programs by which computers operate have often failed to advance at all. One of the primary responses of software companies to increased processing power is to add "useful" features which often make the software harder to use. Microsoft Word reached its apex in 1995 and has been slowly sinking under the weight of added features ever since. Once Moore's Law starts slowing down, software developers will be confronted with hard choices between efficiency, speed, and functionality.

A major fear of the singulariteers is that as computers become more involved in designing their own software they'll rapidly bootstrap themselves into achieving superhuman computational ability. But the evidence of machine learning points in the opposite direction. As machines become more powerful and capable of learning, they learn more and more as human beings do—from multiple examples, often under the supervision of human and machine teachers. Education is as hard and slow for computers as it is for teenagers. Consequently, systems based on deep learning are becoming more rather than less human. The skills they bring to learning are not "better than" but "complementary to" human learning: Computer learning systems can identify patterns that humans cannot—and vice versa. The world's best chess players are neither computers nor humans but humans working together with computers. Cyberspace is indeed inhabited by harmful programs, but these primarily take the form of malware—viruses notable for their malign mindlessness, not for their

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superintelligence.

Whither Wiener

Wiener noted that exponential technological progress is a relatively modern phenomenon and not all of it is good. He regarded atomic weapons and the development of missiles with nuclear warheads as a recipe for the suicide of the human species. He compared the headlong exploitation of the planet's resources with the Mad Tea Party of *Alice in Wonderland:* Having laid waste to one local environment, we make progress simply by moving on to lay waste to the next. Wiener's optimism about the development of computers and neuro-mechanical systems was tempered by his pessimism about their exploitation by authoritarian governments, such as the Soviet Union, and the tendency for democracies, such as the United States, to become more authoritarian themselves in confronting the threat of authoritarianism.

What would Wiener think of the current human use of human beings? He would be amazed by the power of computers and the Internet. He would be happy that the early neural nets in which he played a role have spawned powerful deep-learning systems that exhibit the perceptual ability he demanded of them—although he might not be impressed that one of the most prominent examples of such computerized *Gestalt* is the ability to recognize photos of kittens on the World Wide Web. Rather than regarding machine intelligence as a threat, I suspect he would regard it as a phenomenon in its own right, different from and co-evolving with our own human intelligence.

Unsurprised by global warming—the Mad Tea Party of our era—Wiener would applaud the exponential improvement in alternative-energy technologies and would apply his cybernetic expertise to developing the intricate set of feedback loops needed to incorporate such technologies into the coming smart electrical grid. Nonetheless, recognizing that the solution to the problem of climate change is at least as much political as it is technological, he would undoubtedly be pessimistic about our chances of solving this civilization-threatening problem in time. Wiener hated hucksters—political hucksters most of all—but he acknowledged that hucksters would always be with us.

It's easy to forget just how scary Wiener's world was. The United States and the Soviet Union were in a full-out arms race, building hydrogen bombs mounted on nuclear warheads carried by intercontinental ballistic missiles guided by navigation systems to which Wiener himself—to his dismay—had contributed. I was four years old when Wiener died. In 1964, my nursery school class was practicing duck-and-cover under our desks to prepare for a nuclear attack. Given the human use of human beings in his own day, if he could see our current state, Wiener's first response would be to be relieved that we are still alive.

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In the 1980s, **Judea Pearl** *introduced a new approach to artificial intelligence called Bayesian networks. This probability-based model of machine reasoning enabled machines to function—in a complex and uncertain world—as "evidence engines," continuously revising their beliefs in light of new evidence.*

Within a few years, Judea's Bayesian networks had completely overshadowed the previous rule-based approaches to artificial intelligence. The advent of deep learning—in which computers, in effect, teach themselves to be smarter by observing tons of data, has given him pause, because this method lacks transparency.

While recognizing the impressive achievements in deep learning by colleagues such as Michael Jordan and Geoffrey Hinton, he feels uncomfortable with this kind of opacity. He set out to understand the theoretical limitations of deep-learning systems and points out that basic barriers exist that will prevent them from achieving a human kind of intelligence, no matter what we do. Leveraging the computational benefits of Bayesian networks, Judea realized that the combination of simple graphical models and data could also be used to represent and infer cause-effect relationships. The significance of this discovery far transcends its roots in artificial intelligence. His latest book explains causal thinking to the general public; you might say it is a primer on how to think even though human.

Judea's principled, mathematical approach to causality is a profound contribution to the realm of ideas. It has already benefited virtually every field of inquiry, especially the data-intensive health and social sciences.

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THE LIMITATIONS OF OPAQUE LEARNING MACHINES

Judea Pearl

Judea Pearl *is a professor of computer science and director of the Cognitive Systems Laboratory at UCLA. His most recent book, co-authored with Dana Mackenzie, is* The Book of Why: The New Science of Cause and Effect.

As a former physicist, I was extremely interested in cybernetics. Though it did not utilize the full power of Turing Machines, it was highly transparent, perhaps because it was founded on classical control theory and information theory. We are losing this transparency now, with the deep-learning style of machine learning. It is fundamentally a curve-fitting exercise that adjusts weights in intermediate layers of a long input-output chain.

I find many users who say that it "works well and we don't know why." Once you unleash it on large data, deep learning has its own dynamics, it does its own repair and its own optimization, and it gives you the right results most of the time. But when it doesn't, you don't have a clue about what went wrong and what should be fixed. In particular, you do not know if the fault is in the program, in the method, or because things have changed in the environment. We should be aiming at a different kind of transparency.

Some argue that transparency is not really needed. We don't understand the neural architecture of the human brain, yet it runs well, so we forgive our meager understanding and use human helpers to great advantage. In the same way, they argue, why not unleash deep-learning systems and create intelligence without understanding how they work? I buy this argument to some extent. I personally don't like opacity, so I won't spend my time on deep learning, but I know that it has a place in the makeup of intelligence. I know that non-transparent systems can do marvelous jobs, and our brain is proof of that marvel.

But this argument has its limitation. The reason we can forgive our meager understanding of how human brains work is because our brains work the same way, and that enables us to communicate with other humans, learn from them, instruct them, and motivate them in our own native language. If our robots will all be as opaque as AlphaGo, we won't be able to hold a meaningful conversation with them, and that would be unfortunate. We will need to retrain them whenever we make a slight change in the task or in the operating environment.

So, rather than experimenting with opaque learning machines, I am trying to understand their theoretical limitations and examine how these limitations can be overcome. I do it in the context of causal-reasoning tasks, which govern much of how scientists think about the world and, at the same time, are rich in intuition and toy examples, so we can monitor the progress in our analysis. In this context, we've discovered that some basic barriers exist, and that unless they are breached we won't get a real human kind of intelligence no matter what we do. I believe that charting these barriers may be no less important than banging our heads against them.

Current machine-learning systems operate almost exclusively in a statistical, or model-blind, mode, which is analogous in many ways to fitting a function to a cloud of data points. Such systems cannot reason about "what if ?" questions and, therefore,

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cannot serve as the basis for Strong AI—that is, artificial intelligence that emulates human-level reasoning and competence. To achieve human-level intelligence, learning machines need the guidance of a blueprint of reality, a model—similar to a road map that guides us in driving through an unfamiliar city.

To be more specific, current learning machines improve their performance by optimizing parameters for a stream of sensory inputs received from the environment. It is a slow process, analogous to the natural-selection process that drives Darwinian evolution. It explains how species like eagles and snakes have developed superb vision systems over millions of years. It cannot explain, however, the super-evolutionary process that enabled humans to build eyeglasses and telescopes over barely a thousand years. What humans had that other species lacked was a mental representation of their environment—representations that they could manipulate at will to imagine alternative hypothetical environments for planning and learning.

Historians of *Homo sapiens* such as Yuval Noah Harari and Steven Mithen are in general agreement that the decisive ingredient that gave our ancestors the ability to achieve global dominion about forty thousand years ago was their ability to create and store a mental representation of their environment, interrogate that representation, distort it by mental acts of imagination, and finally answer the "What if?" kind of questions. Examples are interventional questions ("What if I do such-and-such?") and retrospective or counterfactual questions ("What if I had acted differently?"). No learning machine in operation today can answer such questions. Moreover, most learning machines do not possess a representation from which the answers to such questions can be derived.

With regard to causal reasoning, we find that you can do very little with any form of model-blind curve fitting, or any statistical inference, no matter how sophisticated the fitting process is. We have also found a theoretical framework for organizing such limitations, which forms a hierarchy.

On the first level, you have statistical reasoning, which can tell you only how seeing one event would change your belief about another. For example, what can a symptom tell you about a disease?

Then you have a second level, which entails the first but not vice versa. It deals with actions. "What will happen if we raise prices?" "What if you make me laugh?" That second level of the hierarchy requires information about interventions which is not available in the first. This information can be encoded in a graphical model, which merely tells us which variable responds to another.

The third level of the hierarchy is the counterfactual. This is the language used by scientists. "What if the object were twice as heavy?" "What if I were to do things differently?" "Was it the aspirin that cured my headache, or the nap I took?" Counterfactuals are at the top level in the sense that they cannot be derived even if we could predict the effects of all actions. They need an extra ingredient, in the form of equations, to tell us how variables respond to changes in other variables.

One of the crowning achievements of causal-inference research has been the algorithmization of both interventions and counterfactuals, the top two layers of the hierarchy. In other words, once we encode our scientific knowledge in a model (which may be qualitative), algorithms exist that examine the model and determine if a given query, be it about an intervention or about a counterfactual, can be estimated from the available data—and, if so, how. This capability has transformed dramatically the way

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scientists are doing science, especially in such data-intensive sciences as sociology and epidemiology, for which causal models have become a second language. These disciplines view their linguistic transformation as the Causal Revolution. As Harvard social scientist Gary King puts it, "More has been learned about causal inference in the last few decades than the sum total of everything that had been learned about it in all prior recorded history."

As I contemplate the success of machine learning and try to extrapolate it to the future of AI, I ask myself, "Are we aware of the basic limitations that were discovered in the causal-inference arena? Are we prepared to circumvent the theoretical impediments that prevent us from going from one level of the hierarchy to another level?"

I view machine learning as a tool to get us from data to probabilities. But then we still have to make two extra steps to go from probabilities into real understandingnce—two big steps. One is to predict the effect of actions, and the second is counterfactual imagination. We cannot claim to understand reality unless we make the last two steps.

In his insightful book *Foresight and Understanding* (1961), the philosopher Stephen Toulmin identified the transparency-versus-opacity contrast as the key to understanding the ancient rivalry between Greek and Babylonian sciences. According to Toulmin, the Babylonian astronomers were masters of black-box predictions, far surpassing their Greek rivals in accuracy and consistency of celestial observations. Yet Science favored the creative-speculative strategy of the Greek astronomers, which was wild with metaphorical imagery: circular tubes full of fire, small holes through which celestial fire was visible as stars, and hemispherical Earth riding on turtleback. It was this wild modeling strategy, not Babylonian extrapolation, that jolted Eratosthenes (276-194 BC) to perform one of the most creative experiments in the ancient world and calculate the circumference of the Earth. Such an experiment would never have occurred to a Babylonian data-fitter.

Model-blind approaches impose intrinsic limitations on the cognitive tasks that Strong AI can perform. My general conclusion is that human-level AI cannot emerge solely from model-blind learning machines; it requires the symbiotic collaboration of data and models.

Data science is a science only to the extent that it facilitates the interpretation of data—a two-body problem, connecting data to reality. Data alone are hardly a science, no matter how "big" they get and how skillfully they are manipulated. Opaque learning systems may get us to Babylon, but not to Athens.

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Computer scientist **Stuart Russell**, *along with Elon Musk, Stephen Hawking, Max Tegmark, and numerous others, has insisted that attention be paid to the potential dangers in creating an intelligence on the superhuman (or even the human) level—an AGI, or artificial general intelligence, whose programmed purposes may not necessarily align with our own.*

His early work was on understanding the notion of "bounded optimality" as a formal definition of intelligence that you can work on. He developed the technique of rational meta-reasoning, "which is, roughly speaking, that you do the computations that you expect to improve the quality of your ultimate decision as quickly as possible." He has also worked on the unification of probability theory and first-order logic—resulting in a new and far more effective monitoring system for the Comprehensive Nuclear Test Ban Treaty—and on the problem of decision making over long timescales (his presentations on the latter topic are usually titled, "Life: Play and Win in 20 trillion moves").

He is very concerned with the continuing development of autonomous weapons, such as lethal micro-drones, which are potentially scalable into weapons of mass destruction. He drafted the letter from forty of the world's leading AI researchers to President Obama which resulted in high-level national-security meetings.

His current work centers on the creation of what he calls "provably beneficial" AI. He wants to ensure AI safety by "imbuing systems with explicit uncertainty" about the objectives of their human programmers, an approach that would amount to a fairly radical reordering of current AI research.

Stuart is also on the radar of anyone who has taken a course in computer science in the last twenty-odd years. He is co-author of "the" definitive AI textbook, with an estimated 5-million-plus English-language readers.

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THE PURPOSE PUT INTO THE MACHINE

Stuart Russell

***Stuart Russell** is a professor of computer science and Smith-Zadeh Professor in Engineering at UC Berkeley. He is the coauthor (with Peter Norvig) of* Artificial Intelligence: A Modern Approach.

Among the many issues raised in Norbert Wiener's *The Human Use of Human Beings* (1950) that are currently relevant, the most significant to the AI researcher is the possibility that humanity may cede control over its destiny to machines.

Wiener considered the machines of the near future as far too limited to exert global control, imagining instead that machines and machine-like control systems would be wielded by human elites to reduce the great mass of humanity to the status of "cogs and levers and rods." Looking further ahead, he pointed to the difficulty of correctly specifying objectives for highly capable machines, noting

> a few of the simpler and more obvious truths of life, such as that when a djinnee is found in a bottle, it had better be left there; that the fisherman who craves a boon from heaven too many times on behalf of his wife will end up exactly where he started; that if you are given three wishes, you must be very careful what you wish for.

The dangers are clear enough:

> Woe to us if we let [the machine] decide our conduct, unless we have previously examined the laws of its action, and know fully that its conduct will be carried out on principles acceptable to us! On the other hand, the machine like the djinnee, which can learn and can make decisions on the basis of its learning, will in no way be obliged to make such decisions as we should have made, or will be acceptable to us.

Ten years later, after seeing Arthur Samuel's checker-playing program learn to play checkers far better than its creator, Wiener published "Some Moral and Technical Consequences of Automation" in *Science*. In this paper, the message is even clearer:

> If we use, to achieve our purposes, a mechanical agency with whose operation we cannot efficiently interfere . . . we had better be quite sure that the purpose put into the machine is the purpose which we really desire. . . .

In my view, this is the source of the existential risk from superintelligent AI cited in recent years by such observers as Elon Musk, Bill Gates, Stephen Hawking, and Nick Bostrom.

Putting Purposes Into Machines

The goal of AI research has been to understand the principles underlying intelligent behavior and to build those principles into machines that can then exhibit such behavior. In the 1960s and 1970s, the prevailing theoretical notion of intelligence was the capacity for logical reasoning, including the ability to derive plans of action guaranteed to achieve a specified goal. More recently, a consensus has emerged around the idea of a rational

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agent that perceives, and acts in order to maximize, its expected utility. Subfields such as logical planning, robotics, and natural-language understanding are special cases of the general paradigm. AI has incorporated probability theory to handle uncertainty, utility theory to define objectives, and statistical learning to allow machines to adapt to new circumstances. These developments have created strong connections to other disciplines that build on similar concepts, including control theory, economics, operations research, and statistics.

In both the logical-planning and rational-agent views of AI, the machine's objective—whether in the form of a goal, a utility function, or a reward function (as in reinforcement learning)—is specified exogenously. In Wiener's words, this is "the purpose put into the machine." Indeed, it has been one of the tenets of the field that AI systems should be general-purpose—i.e., capable of accepting a purpose as input and then achieving it—rather than special-purpose, with their goal implicit in their design. For example, a self-driving car should accept a destination as input instead of having one fixed destination. However, some aspects of the car's "driving purpose" are fixed, such as that it shouldn't hit pedestrians. This is built directly into the car's steering algorithms rather than being explicit: No self-driving car in existence today "knows" that pedestrians prefer not to be run over.

Putting a purpose into a machine which optimizes its behavior according to clearly defined algorithms seems an admirable approach to ensuring that the machine's "conduct will be carried out on principles acceptable to us!" But, as Wiener warns, we need to put in the right purpose. We might call this the King Midas problem: Midas got exactly what he asked for—namely, that everything he touched would turn to gold—but too late he discovered the drawbacks of drinking liquid gold and eating solid gold. The technical term for putting in the right purpose is *value alignment*. When it fails, we may inadvertently imbue machines with objectives counter to our own. Tasked with finding a cure for cancer as fast as possible, an AI system might elect to use the entire human population as guinea pigs for its experiments. Asked to de-acidify the oceans, it might use up all the oxygen in the atmosphere as a side effect. This is a common characteristic of systems that optimize: Variables not included in the objective may be set to extreme values to help optimize that objective.

Unfortunately, neither AI nor other disciplines (economics, statistics, control theory, operations research) built around the optimization of objectives have much to say about how to identify the purposes "we really desire." Instead, they assume that objectives are simply implanted into the machine. AI research, in its present form, studies the ability to achieve objectives, not the design of those objectives.

Steve Omohundro has pointed to a further difficulty, observing that intelligent entities must act to preserve their own existence. This tendency has nothing to do with a self-preservation instinct or any other biological notion; it's just that an entity cannot achieve its objectives if it's dead. According to Omohundro's argument, a superintelligent machine that has an off-switch—which some, including Alan Turing himself, in a 1951 talk on BBC Radio 3, have seen as our potential salvation—will take steps to disable the switch in some way.[1] Thus we may face the prospect of superintelligent machines—their actions by definition unpredictable by us and their

[1] Omohundro, "The Basic AI Drives," in *Proc. First AGI Conf.,* 171: "Artificial General Intelligence," eds. P. Wang, B. Goertzel, & S. Franklin (IOS press, 2008).

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imperfectly specified objectives conflicting with our own—whose motivation to preserve their existence in order to achieve those objectives may be insuperable.

1001 Reasons to Pay No Attention

Objections have been raised to these arguments, primarily by researchers within the AI community. The objections reflect a natural defensive reaction, coupled perhaps with a lack of imagination about what a superintelligent machine could do. None hold water on closer examination. Here are some of the more common ones:

- *Don't worry, we can just switch it off.*[2] This is often the first thing that pops into a layperson's head when considering risks from superintelligent AI—as if a superintelligent entity would never think of that. This is rather like saying that the risk of losing to DeepBlue or AlphaGo is negligible—all one has to do is make the right moves.
- *Human-level or superhuman AI is impossible.*[3] This is an unusual claim for AI researchers to make, given that, from Turing onward, they have been fending off such claims from philosophers and mathematicians. The claim, which is backed by no evidence, appears to concede that if superintelligent AI *were* possible, it *would* be a significant risk. It's as if a bus driver, with all of humanity as passengers, said, "Yes, I am driving toward a cliff—in fact, I'm pressing the pedal to the metal! But trust me, we'll run out of gas before we get there!" The claim represents a foolhardy bet against human ingenuity. We have made such bets before and lost. On September 11, 1933, renowned physicist Ernest Rutherford stated, with utter confidence, "Anyone who expects a source of power from the transformation of these atoms is talking moonshine." On September 12, 1933, Leo Szilard invented the neutron-induced nuclear chain reaction. A few years later he demonstrated such a reaction in his laboratory at Columbia University. As he recalled in a memoir: "We switched everything off and went home. That night, there was very little doubt in my mind that the world was headed for grief."
- *It's too soon to worry about it.* The right time to worry about a potentially serious problem for humanity depends not just on when the problem will occur but also on how much time is needed to devise and implement a solution that avoids the risk. For example, if we were to detect a large asteroid predicted to collide with the Earth in 2067, would we say, "It's too soon to worry"? And if we consider the global catastrophic risks from climate change predicted to occur later in this century, is it too soon to take action to prevent them? On the contrary, it may be too late. The relevant timescale for human-level AI is less predictable, but, like nuclear fission, it might arrive considerably sooner than expected. One variation on this argument is Andrew Ng's statement that it's "like worrying about overpopulation on Mars." This appeals to a convenient analogy: Not only is the

[2] AI researcher Jeff Hawkins, for example, writes, "Some intelligent machines will be virtual, meaning they will exist and act solely within computer networks. . . . It is always possible to turn off a computer network, even if painful." https://www.recode.net/2015/3/2/11559576/.

[3] The AI100 report (Peter Stone *et al.*), sponsored by Stanford University, includes the following: "Unlike in the movies, there is no race of superhuman robots on the horizon or probably even possible." https://ai100.stanford.edu/2016-report.

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risk easily managed and far in the future, but also it's extremely unlikely that we'd even try to move billions of humans to Mars in the first place. The analogy is a false one, however. We are already devoting huge scientific and technical resources to creating ever-more-capable AI systems. A more apt analogy would be a plan to move the human race to Mars with no consideration for what we might breathe, drink, or eat once we'd arrived.

- *Human-level AI isn't really imminent, in any case.* The AI100 report, for example, assures us, "Contrary to the more fantastic predictions for AI in the popular press, the Study Panel found no cause for concern that AI is an imminent threat to humankind." This argument simply misstates the reasons for concern, which are not predicated on imminence. In his 2014 book, *Superintelligence: Paths, Dangers, Strategies,* Nick Bostrom, for one, writes, "It is no part of the argument in this book that we are on the threshold of a big breakthrough in artificial intelligence, or that we can predict with any precision when such a development might occur."
- *You're just a Luddite.* It's an odd definition of Luddite that includes Turing, Wiener, Minsky, Musk, and Gates, who rank among the most prominent contributors to technological progress in the 20th and 21st centuries.[4] Furthermore, the epithet represents a complete misunderstanding of the nature of the concerns raised and the purpose for raising them. It is as if one were to accuse nuclear engineers of Luddism if they pointed out the need for control of the fission reaction. Some objectors also use the term "anti-AI," which is rather like calling nuclear engineers "anti-physics." The purpose of understanding and preventing the risks of AI is to ensure that we can realize the benefits. Bostrom, for example, writes that success in controlling AI will result in "a civilizational trajectory that leads to a compassionate and jubilant use of humanity's cosmic endowment"—hardly a pessimistic prediction.
- *Any machine intelligent enough to cause trouble will be intelligent enough to have appropriate and altruistic objectives.*[5] (Often, the argument adds the premise that people of greater intelligence tend to have more altruistic objectives, a view that may be related to the self-conception of those making the argument.) This argument is related to Hume's *is-ought* problem and G. E. Moore's naturalistic fallacy, suggesting that somehow the machine, as a result of its intelligence, will simply *perceive* what is right, given its experience of the world. This is implausible; for example, one cannot perceive, in the design of a chessboard and chess pieces, the goal of checkmate; the same chessboard and pieces can be used for suicide chess, or indeed many other games still to be invented. Put another way: Where Bostrom imagines humans driven extinct by a putative robot that turns the planet into a sea of paper clips, we humans see this outcome as tragic,

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[4] Elon Musk, Stephen Hawking, and others (including, apparently, the author) received the 2015 Luddite of the Year Award from the Information Technology Innovation Foundation: https://itif.org/publications/2016/01/19/artificial-intelligence-alarmists-win-itif%E2%80%99s-annual-luddite-award.

[5] Rodney Brooks, for example, asserts that it's impossible for a program to be "smart enough that it would be able to invent ways to subvert human society to achieve goals set for it by humans, without understanding the ways in which it was causing problems for those same humans." http://rodneybrooks.com/the-seven-deadly-sins-of-predicting-the-future-of-ai/.

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whereas the iron-eating bacterium *Thiobacillus ferrooxidans* is thrilled. Who's to say the bacterium is wrong? The fact that a machine has been given a fixed objective by humans doesn't mean that it will automatically recognize the importance to humans of things that aren't part of the objective. Maximizing the objective may well cause problems for humans, but, by definition, the machine will not recognize those problems as problematic.

- *Intelligence is multidimensional, "so 'smarter than humans' is a meaningless concept."*[6] It is a staple of modern psychology that IQ doesn't do justice to the full range of cognitive skills that humans possess to varying degrees. IQ is indeed a crude measure of human intelligence, but it is utterly meaningless for current AI systems, because their capabilities across different areas are uncorrelated. How do we compare the IQ of Google's search engine, which cannot play chess, with that of DeepBlue, which cannot answer search queries?

  None of this supports the argument that because intelligence is multifaceted, we can ignore the risk from superintelligent machines. If "smarter than humans" is a meaningless concept, then "smarter than gorillas" is also meaningless, and gorillas therefore have nothing to fear from humans; clearly, that argument doesn't hold water. Not only is it logically possible for one entity to be more capable than another across all the relevant dimensions of intelligence, it is also possible for one species to represent an existential threat to another even if the former lacks an appreciation for music and literature.

Solutions

Can we tackle Wiener's warning head-on? Can we design AI systems whose purposes don't conflict with ours, so that we're sure to be happy with how they behave? On the face of it, this seems hopeless, because it will doubtless prove infeasible to write down our purposes correctly or imagine all the counterintuitive ways a superintelligent entity might fulfill them.

If we treat superintelligent AI systems as if they were black boxes from outer space, then indeed we have no hope. Instead, the approach we seem obliged to take, if we are to have any confidence in the outcome, is to define some formal problem F, and design AI systems to be F-solvers, such that no matter how perfectly a system solves F, we're guaranteed to be happy with the solution. If we can work out an appropriate F that has this property, we'll be able to create *provably beneficial* AI.

Here's an example of how *not* to do it: Let a reward be a scalar value provided periodically by a human to the machine, corresponding to how well the machine has behaved during each period, and let F be the problem of maximizing the expected sum of rewards obtained by the machine. The optimal solution to this problem is not, as one might hope, to behave well, but instead to take control of the human and force him or her to provide a stream of maximal rewards. This is known as the wireheading problem, based on observations that humans themselves are susceptible to the same problem if given a means to electronically stimulate their own pleasure centers.

There is, I believe, an approach that may work. Humans can reasonably be described as having (mostly implicit) preferences over their future lives—that is, given

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[6] Kevin Kelly, "The Myth of a Superhuman AI," *Wired*, Apr. 25, 2017.

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enough time and unlimited visual aids, a human could express a preference (or indifference) when offered a choice between two future lives laid out before him or her in all their aspects. (This idealization ignores the possibility that our minds are composed of subsystems with incompatible preferences; if true, that would limit a machine's ability to optimally satisfy our preferences, but it doesn't seem to prevent us from designing machines that avoid catastrophic outcomes.) The formal problem F to be solved by the machine in this case is to maximize human future-life preferences subject to its initial uncertainty as to what they are. Furthermore, although the future-life preferences are hidden variables, they're grounded in a voluminous source of evidence—namely, all of the human choices ever made. This formulation sidesteps Wiener's problem: The machine may learn more about human preferences as it goes along, of course, but it will never achieve complete certainty.

A more precise definition is given by the framework of cooperative inverse-reinforcement learning, or CIRL. A CIRL problem involves two agents, one human and the other a robot. Because there are two agents, the problem is what economists call a game. It is a game of partial information, because while the human knows the reward function, the robot doesn't—even though the robot's job is to maximize it.

A simple example: Suppose that Harriet, the human, likes to collect paper clips and staples and her reward function depends on how many of each she has. More precisely, if she has p paper clips and s staples, her degree of happiness is $\theta p + (1-\theta)s$, where θ *is* essentially an exchange rate between paper clips and staples. If θ is 1, she likes only paper clips; if θ is 0, she likes only staples; if θ is 0.5, she is indifferent between them; and so on. It's the job of Robby, the robot, to produce the paper clips and staples. The point of the game is that Robby wants to make Harriet happy, but he doesn't know the value of θ, so he isn't sure how many of each to produce.

Here's how the game works. Let the true value of θ be 0.49—that is, Harriet has a slight preference for staples over paper clips. And let's assume that Robby has a uniform prior belief about θ—that is, he believes θ is equally likely to be any value between 0 and 1. Harriet now gets to do a small demonstration, producing either two paper clips or two staples or one of each. After that, the robot can produce either ninety paper clips, or ninety staples, or fifty of each. You might think that Harriet, who prefers staples to paper clips, should produce two staples. But in that case, Robby's rational response would be to produce ninety staples (with a total value to Harriet of 45.9), which is a less desirable outcome for Harriet than fifty of each (total value 50.0). The optimal solution of this particular game is that Harriet produces one of each, so then Robby makes fifty of each. Thus, the way the game is defined encourages Harriet to "teach" Robby—as long as she knows that Robby is watching carefully.

Within the CIRL framework, one can formulate and solve the off-switch problem—that is, the problem of how to prevent a robot from disabling its off-switch. (Turing may rest easier.) A robot that's uncertain about human preferences actually benefits from being switched off, because it understands that the human will press the off-switch to prevent the robot from doing something counter to those preferences. Thus the robot is incentivized to preserve the off-switch, and this incentive derives directly from its uncertainty about human preferences.[7]

The off-switch example suggests some templates for controllable-agent

[7] See Hadfield-Menell et al., "The Off-Switch Game," https://arxiv.org/pdf/1611.08219.pdf.

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designs and provides at least one case of a provably beneficial system in the sense introduced above. The overall approach resembles mechanism-design problems in economics, wherein one incentivizes other agents to behave in ways beneficial to the designer. The key difference here is that we are building one of the agents in order to benefit the other.

There are reasons to think this approach may work in practice. First, there is abundant written and filmed information about humans doing things (and other humans reacting). Technology to build models of human preferences from this storehouse will presumably be available long before superintelligent AI systems are created. Second, there are strong, near-term economic incentives for robots to understand human preferences: If one poorly designed domestic robot cooks the cat for dinner, not realizing that its sentimental value outweighs its nutritional value, the domestic-robot industry will be out of business.

There are obvious difficulties, however, with an approach that expects a robot to learn underlying preferences from human behavior. Humans are irrational, inconsistent, weak-willed, and computationally limited, so their actions don't always reflect their true preferences. (Consider, for example, two humans playing chess. Usually, one of them loses, but not on purpose!) So robots can learn from nonrational human behavior only with the aid of much better cognitive models of humans. Furthermore, practical and social constraints will prevent all preferences from being maximally satisfied simultaneously, which means that robots must mediate among conflicting preferences—something that philosophers and social scientists have struggled with for millennia. And what should robots learn from humans who enjoy the suffering of others? It may be best to zero out such preferences in the robots' calculations.

Finding a solution to the AI control problem is an important task; it may be, in Bostrom's words, "the essential task of our age." Up to now, AI research has focused on systems that are better at making decisions, but this is not the same as making better decisions. No matter how excellently an algorithm maximizes, and no matter how accurate its model of the world, a machine's decisions may be ineffably stupid in the eyes of an ordinary human if its utility function is not well aligned with human values.

This problem requires a change in the definition of AI itself—from a field concerned with pure intelligence, independent of the objective, to a field concerned with systems that are provably beneficial for humans. Taking the problem seriously seems likely to yield new ways of thinking about AI, its purpose, and our relationship to it.

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In 2005, **George Dyson**, *a historian of science and technology, visited Google at the invitation of some Google engineers. The occasion was the sixtieth anniversary of John von Neumann's proposal for a digital computer. After the visit, George wrote an essay, "Turing's Cathedral," which, for the first time, alerted the public about what Google's founders had in store for the world. "We are not scanning all those books to be read by people," explained one of his hosts after his talk. "We are scanning them to be read by an AI."*

George offers a counternarrative to the digital age. His interests have included the development of the Aleut kayak, the evolution of digital computing and telecommunications, the origins of the digital universe, and a path not taken into space. His career (he never finished high school, yet has been awarded an honorary doctorate from the University of Victoria) has proved as impossible to classify as his books.

He likes to point out that analog computing, once believed to be as extinct as the differential analyzer, has returned. He argues that while we may use digital components, at a certain point the analog computing being performed by the system far exceeds the complexity of the digital code with which it is built. He believes that true artificial intelligence—with analog control systems emerging from a digital substrate the way digital computers emerged out of analog components in the aftermath of World War II—may not be as far off as we think.

In this essay, George contemplates the distinction between analog and digital computation and finds analog to be alive and well. Nature's response to an attempt to program machines to control everything may be machines without programming over which no one has control.

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THE THIRD LAW
George Dyson

***George Dyson** is a historian of science and technology and the author of* Baidarka: the Kayak, Darwin Among the Machines, Project Orion, *and* Turing's Cathedral.

The history of computing can be divided into an Old Testament and a New Testament: before and after electronic digital computers and the codes they spawned proliferated across the Earth. The Old Testament prophets, who delivered the underlying logic, included Thomas Hobbes and Gottfried Wilhelm Leibniz. The New Testament prophets included Alan Turing, John von Neumann, Claude Shannon, and Norbert Wiener. They delivered the machines.

Alan Turing wondered what it would take for machines to become intelligent. John von Neumann wondered what it would take for machines to self-reproduce. Claude Shannon wondered what it would take for machines to communicate reliably, no matter how much noise intervened. Norbert Wiener wondered how long it would take for machines to assume control.

Wiener's warnings about control systems beyond human control appeared in 1949, just as the first generation of stored-program electronic digital computers were introduced. These systems required direct supervision by human programmers, undermining his concerns. What's the problem, as long as programmers are in control of the machines? Ever since, debate over the risks of autonomous control has remained associated with the debate over the powers and limitations of digitally coded machines. Despite their astonishing powers, little real autonomy has been observed. This is a dangerous assumption. What if digital computing is being superseded by something else?

Electronics underwent two fundamental transitions over the past hundred years: from analog to digital and from vacuum tubes to solid state. That these transitions occurred together does not mean they are inextricably linked. Just as digital computation was implemented using vacuum tube components, analog computation can be implemented in solid state. Analog computation is alive and well, even though vacuum tubes are commercially extinct.

There is no precise distinction between analog and digital computing. In general, digital computing deals with integers, binary sequences, deterministic logic, and time that is idealized into discrete increments, whereas analog computing deals with real numbers, nondeterministic logic, and continuous functions, including time as it exists as a continuum in the real world.

Imagine you need to find the middle of a road. You can measure its width using any available increment and then digitally compute the middle to the nearest increment. Or you can use a piece of string as an analog computer, mapping the width of the road to the length of the string and finding the middle, without being limited to increments, by doubling the string back upon itself.

Many systems operate across both analog and digital regimes. A tree integrates a wide range of inputs as continuous functions, but if you cut down that tree, you find that it has been counting the years digitally all along.

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In analog computing, complexity resides in network topology, not in code. Information is processed as continuous functions of values such as voltage and relative pulse frequency rather than by logical operations on discrete strings of bits. Digital computing, intolerant of error or ambiguity, depends upon error correction at every step along the way. Analog computing tolerates errors, allowing you to live with them.

Nature uses digital coding for the storage, replication, and recombination of sequences of nucleotides, but relies on analog computing, running on nervous systems, for intelligence and control. The genetic system in every living cell is a stored-program computer. Brains aren't.

Digital computers execute transformations between two species of bits: bits representing differences in space and bits representing differences in time. The transformations between these two forms of information, sequence and structure, are governed by the computer's programming, and as long as computers require human programmers, we retain control.

Analog computers also mediate transformations between two forms of information: structure in space and behavior in time. There is no code and no programming. Somehow—and we don't fully understand how—Nature evolved analog computers known as nervous systems, which embody information absorbed from the world. They learn. One of the things they learn is control. They learn to control their own behavior, and they learn to control their environment to the extent that they can.

Computer science has a long history—going back to before there even *was* computer science—of implementing neural networks, but for the most part these have been simulations of neural networks by digital computers, not neural networks as evolved in the wild by Nature herself. This is starting to change: from the bottom up, as the threefold drivers of drone warfare, autonomous vehicles, and cell phones push the development of neuromorphic microprocessors that implement actual neural networks, rather than simulations of neural networks, directly in silicon (and other potential substrates); and from the top down, as our largest and most successful enterprises increasingly turn to analog computation in their infiltration and control of the world.

While we argue about the intelligence of digital computers, analog computing is quietly supervening upon the digital, in the same way that analog components like vacuum tubes were repurposed to build digital computers in the aftermath of World War II. Individually deterministic finite-state processors, running finite codes, are forming large-scale, nondeterministic, non-finite-state metazoan organisms running wild in the real world. The resulting hybrid analog/digital systems treat streams of bits collectively, the way the flow of electrons is treated in a vacuum tube, rather than individually, as bits are treated by the discrete-state devices generating the flow. Bits are the new electrons. Analog is back, and its nature is to assume control.

Governing everything from the flow of goods to the flow of traffic to the flow of ideas, these systems operate statistically, as pulse-frequency coded information is processed in a neuron or a brain. The emergence of intelligence gets the attention of *Homo sapiens,* but what we should be worried about is the emergence of control.

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Imagine it is 1958 and you are trying to defend the continental United States against airborne attack. To distinguish hostile aircraft, one of the things you need, besides a network of computers and early-warning radar sites, is a map of all commercial air traffic, updated in real time. The United States built such a system and named it SAGE (Semi-Automatic Ground Environment). SAGE in turn spawned Sabre, the first integrated reservation system for booking airline travel in real time. Sabre and its progeny soon became not just a map as to what seats were available but also a system that began to control, with decentralized intelligence, where airliners would fly, and when.

But isn't there a control room somewhere, with someone at the controls? Maybe not. Say, for example, you build a system to map highway traffic in real time, simply by giving cars access to the map in exchange for reporting their own speed and location at the time. The result is a fully decentralized control system. Nowhere is there any controlling model of the system except the system itself.

Imagine it is the first decade of the 21st century and you want to track the complexity of human relationships in real time. For social life at a small college, you could construct a central database and keep it up to date, but its upkeep would become overwhelming if taken to any larger scale. Better to pass out free copies of a simple semi-autonomous code, hosted locally, and let the social network update itself. This code is executed by digital computers, but the analog computing performed by the system as a whole far exceeds the complexity of the underlying code. The resulting pulse-frequency coded model of the social graph *becomes* the social graph. It spreads wildly across the campus and then the world.

What if you wanted to build a machine to capture what everything known to the human species *means*? With Moore's Law behind you, it doesn't take too long to digitize all the information in the world. You scan every book ever printed, collect every email ever written, and gather forty-nine years of video every twenty-four hours, while tracking where people are and what they do, in real time. But how do you capture the *meaning*?

Even in the age of all things digital, this cannot be defined in any strictly logical sense, because meaning, among humans, isn't fundamentally logical. The best you can do, once you have collected all possible answers, is to invite well-defined questions and compile a pulse-frequency weighted map of how everything connects. Before you know it, your system will not only be observing and mapping the meaning of things, it will start *constructing* meaning as well. In time, it will *control* meaning, in the same way as the traffic map starts to control the flow of traffic even though no one seems to be in control.

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There are three laws of artificial intelligence. The first, known as Ashby's Law, after cybernetician W. Ross Ashby, author of *Design for a Brain*, states that any effective control system must be as complex as the system it controls.

The second law, articulated by John von Neumann, states that the defining characteristic of a complex system is that it constitutes its own simplest behavioral description. The simplest complete model of an organism is the organism itself. Trying to reduce the system's behavior to any formal description makes things more complicated, not less.

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The third law states that any system simple enough to be understandable will not be complicated enough to behave intelligently, while any system complicated enough to behave intelligently will be too complicated to understand.

The Third Law offers comfort to those who believe that until we understand intelligence, we need not worry about superhuman intelligence arising among machines. But there is a loophole in the Third Law. It is entirely possible to build something without understanding it. You don't need to fully understand how a brain works in order to build one that works. This is a loophole that no amount of supervision over algorithms by programmers and their ethical advisors can ever close. Provably "good" AI is a myth. Our relationship with true AI will always be a matter of faith, not proof.

We worry too much about machine intelligence and not enough about self-reproduction, communication, and control. The next revolution in computing will be signaled by the rise of analog systems over which digital programming no longer has control. Nature's response to those who believe they can build machines to control everything will be to allow them to build a machine that controls them instead.

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Dan Dennett *is the philosopher of choice in the AI community. He is perhaps best known in cognitive science for his concept of intentional systems and his model of human consciousness, which sketches a computational architecture for realizing the stream of consciousness in the massively parallel cerebral cortex. That uncompromising computationalism has been opposed by philosophers such as John Searle, David Chalmers, and the late Jerry Fodor, who have protested that the most important aspects of consciousness—intentionality and subjective qualia—cannot be computed.*

Twenty-five years ago, I was visiting Marvin Minsky, one of the original AI pioneers, and asked him about Dan. "He's our best current philosopher—the next Bertrand Russell," said Marvin, adding that unlike traditional philosophers, Dan was a student of neuroscience, linguistics, artificial intelligence, computer science, and psychology: "He's redefining and reforming the role of the philosopher. Of course, Dan doesn't understand my Society-of-Mind theory, but nobody's perfect."

Dan's view of the efforts of AI researchers to create superintelligent AIs is relentlessly levelheaded. What, me worry? In this essay, he reminds us that AIs, above all, should be regarded—and treated—as tools and not as humanoid colleagues.

He has been interested in information theory since his graduate school days at Oxford. In fact, he told me that early in his career he was keenly interested in writing a book about Wiener's cybernetic ideas. As a thinker who embraces the scientific method, one of his charms is his willingness to be wrong. Of a recent piece entitled "What Is Information?" he has announced, "I stand by it, but it's under revision. I'm already moving beyond it and realizing there's a better way of tackling some of these issues." He will most likely remain cool and collected on the subject of AI research, although he has acknowledged, often, that his own ideas evolve—as anyone's ideas should.

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WHAT CAN WE DO?
Daniel C. Dennett

Daniel C. Dennett *is University Professor and Austin B. Fletcher Professor of Philosophy and director of the Center for Cognitive Studies at Tufts University. He is the author of a dozen books, including* Consciousness Explained *and, most recently,* From Bacteria to Bach and Back: The Evolution of Minds.

Many have reflected on the irony of reading a great book when you are too young to appreciate it. Consigning a classic to the *already read* stack and thereby insulating yourself against any further influence while gleaning only a few ill-understood ideas from it is a recipe for neglect that is seldom benign. This struck me with particular force when I reread *The Human Use of Human Beings* more than sixty years after my juvenile encounter. We should all make it a regular practice to reread books from our youth, where we are apt to discover clear previews of some of our own later "discoveries" and "inventions," along with a wealth of insights to which we were bound to be impervious until our minds had been torn and tattered, exercised and enlarged by confrontations with life's problems.

Writing at a time when vacuum tubes were still the primary electronic building blocks and there were only a few actual computers in operation, Norbert Wiener imagined the future we now contend with in impressive detail and with few clear mistakes. Alan Turing's famous 1950 article "Computing Machinery and Intelligence," in the philosophy journal *Mind,* foresaw the development of AI, and so did Wiener, but Wiener saw farther and deeper, recognizing that AI would not just imitate—and replace—human beings in many intelligent activities but change human beings in the process.

> We are but whirlpools in a river of ever-flowing water. We are not stuff that abides, but patterns that perpetuate themselves. (p. 96)

When that was written, it could be comfortably dismissed as yet another bit of Heraclitean overstatement. Yeah, yeah, you can never step in the same river twice. But it contains the seeds of the revolution in outlook. Today we know how to think about complex adaptive systems, strange attractors, extended minds, and homeostasis, a change in perspective that promises to erase the "explanatory gap"[8] between mind and mechanism, spirit and matter, a gap that is still ardently defended by latter-day Cartesians who cannot bear the thought that we—we *ourselves*—are self-perpetuating patterns of information-bearing matter, not "stuff that abides." Those patterns are remarkably resilient and self-restoring but at the same time protean, opportunistic, selfish exploiters of whatever new is available to harness in their quest for perpetuation. And here is where things get dicey, as Wiener recognized. When attractive opportunities abound, we are apt to be willing to pay a little and accept some small, even trivial, cost-of-doing-business for access to new powers. And pretty soon we become so dependent on our new tools that we lose the ability to thrive without them. Options become obligatory.

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[8] Joseph Levine, "Materialism and Qualia: The Explanatory Gap," *Pacific Philosophical Quarterly* 64, pp. 354-61 (1983).

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It's an old, old story, with many well-known chapters in evolutionary history. Most mammals can synthesize their own vitamin C, but primates, having opted for a diet composed largely of fruit, lost the innate ability. We are now obligate ingesters of vitamin C, but not obligate frugivores like our primate cousins, since we have opted for technology that allows us to make, and take, vitamins as needed. The self-perpetuating patterns that we call human beings are now dependent on clothes, cooked food, vitamins, vaccinations, . . . credit cards, smartphones, and the Internet. And—tomorrow if not already today—AI.

Wiener foresaw the problems that Turing and the other optimists have largely overlooked. The real danger, he said, is

> that such machines, though helpless by themselves, may be used by a human being or a block of human beings to increase their control over the rest of the race or that political leaders may attempt to control their populations by means not of machines themselves but through political techniques as narrow and indifferent to human possibility as if they had, in fact, been conceived mechanically. (p. 181)

The power, he recognized, lay primarily in the algorithms, not the hardware they run on, although the hardware of today makes practically possible algorithms that would have seemed preposterously cumbersome in Wiener's day. What can we say about these "techniques" that are "narrow and indifferent to human possibility"? They have been introduced again and again, some obviously benign, some obviously dangerous, and many in the omnipresent middle ground of controversy.

Consider a few of the skirmishes. My late friend Joe Weizenbaum, Wiener's successor as MIT's Jeremiah of hi-tech, loved to observe that credit cards, whatever their virtues, also provided an inexpensive and almost foolproof way for the government, or corporations, to track the travels and habits and desires of individuals. The anonymity of cash has been largely underappreciated, except by drug dealers and other criminals, and now it may be going extinct. This may make money laundering a more difficult technical challenge in the future, but the AI pattern finders arrayed against it have the side effect of making us all more transparent to any "block of human beings" that may "attempt to control" us.

Looking to the arts, the innovation of digital audio and video recording lets us pay a small price (in the eyes of all but the most ardent audiophiles and film lovers) when we abandon analog formats, and in return provides easy—all too easy?—reproduction of artworks with almost perfect fidelity. But there is a huge hidden cost. Orwell's Ministry of Truth is now a practical possibility. AI techniques for creating all-but-undetectable forgeries of "recordings" of encounters are now becoming available which will render obsolete the tools of investigation we have come to take for granted in the last hundred and fifty years. Will we simply abandon the brief Age of Photographic Evidence and return to the earlier world in which human memory and trust provided the gold standard, or will we develop new techniques of defense and offense in the arms race of truth? (We can imagine a return to *analog* film-exposed-to-light, kept in "tamper-proof" systems until shown to juries, etc., but how long would it be before somebody figured out a way to infect such systems with doubt? One of the disturbing lessons of recent experience is that the task of destroying a reputation for credibility is much less expensive than the task of protecting such a reputation.) Wiener saw the phenomenon at its most general: "…in

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the long run, there is no distinction between arming ourselves and arming our enemies." (p. 129) The Information Age is also the Dysinformation Age.

What can we do? We need to rethink our priorities with the help of the passionate but flawed analyses of Wiener, Weizenbaum, and the other serious critics of our technophilia. A key phrase, it seems to me, is Wiener's almost offhand observation, above, that "these machines" are "helpless by themselves." As I have been arguing recently, we're making tools, not colleagues, and the great danger is not appreciating the difference, which we should strive to accentuate, marking and defending it with political and legal innovations.

Perhaps the best way to see what is being missed is to note that Alan Turing himself suffered an entirely understandable failure of imagination in his formulation of the famous Turing Test. As everyone knows, it is an adaptation of his "imitation game," in which a man, hidden from view and communicating verbally with a judge, tries to convince the judge that he is in fact a woman, while a woman, also hidden and communicating with the judge, tries to convince the judge that she is the woman. Turing reasoned that this would be a demanding challenge for a man (or for a woman pretending to be a man), exploiting a wealth of knowledge about how the other sex thinks and acts, what they tend to favor or ignore. Surely (*ding!*)[9], any man who could beat a woman at being perceived to be a woman would be an intelligent agent. What Turing did not foresee is the power of deep-learning AI to acquire this wealth of information in an exploitable form *without having to understand it.* Turing imagined an astute and imaginative (and hence conscious) agent who cunningly designed his responses based on his detailed "theory" of what women are likely to do and say. Top-down intelligent design, in short. He certainly didn't think that a man, winning the imitation game, would somehow *become* a woman; he imagined that there would still be a man's consciousness guiding the show. The hidden premise in Turing's almost-argument was: Only a conscious, intelligent *agent* could devise and control a winning strategy in the imitation game. And so it was persuasive to Turing (and others, including me, still a stalwart defender of the Turing Test) to argue that a "computing machine" that could pass as human in a contest with a human might not be conscious in just the way a human being is, but would nevertheless have to be a conscious agent of *some* kind. I think this is still a defensible position—the only defensible position—but you have to understand how resourceful and ingenious a judge would have to be to expose the shallowness of the façade that a deep-learning AI (a tool, not a colleague) could present.

What Turing didn't foresee is the uncanny ability of superfast computers to sift mindlessly through Big Data, of which the Internet provides an inexhaustible supply, finding probabilistic patterns in human activity that could be used to pop "authentic"-seeming responses into the output for almost any probe a judge would think to offer. Wiener also underestimates this possibility, seeing the tell-tale weakness of a machine in not being able to

> take into account the vast range of probability that characterizes the human situation. (p.181)

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[9] The *surely alarm* (the habit of having a bell ring in your head whenever you see the word in an argument) is described and defended by me in *Intuition Pumps and Other Tools for Thinking* (2013).

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But taking into account that range of probability is just where the new AI excels. The only chink in the armor of AI is that word "vast"; human possibilities, thanks to language and the culture that it spawns, are truly Vast.[10] No matter how many patterns we may find with AI in the flood of data that has so far found its way onto the Internet, there are Vastly more possibilities that have never been recorded there. Only a fraction (but not a Vanishing fraction) of the world's accumulated wisdom and design and repartee and silliness has made it onto the Internet, but probably a better tactic for the judge to adopt when confronting a candidate in the Turing Test is not to *search* for such items but to *create* them anew. AI in its current manifestations is parasitic on human intelligence. It quite indiscriminately gorges on whatever has been produced by human creators and extracts the patterns to be found there—including some of our most pernicious habits.[11] These machines do not (yet) have the goals or strategies or capacities for self-criticism and innovation to permit them to transcend their databases by reflectively thinking about their own thinking and their own goals. They are, as Wiener says, helpless, not in the sense of being *shackled* agents or *disabled* agents but in the sense of not being agents at all—not having the capacity to be "moved by reasons" (as Kant put it) presented to them. It is important that we keep it that way, which will take some doing.

One of the flaws in Weizenbaum's book *Computer Power and Human Reason,* something I tried in vain to convince him of in many hours of discussion, is that he could never decide which of two theses he wanted to defend: *AI is impossible!* or *AI is possible but evil!* He wanted to argue, with John Searle and Roger Penrose, that "Strong AI" is impossible, but there are no good arguments for that conclusion. After all, everything we now know suggests that, as I have put it, we are robots made of robots made of robots. . . down to the motor proteins and their ilk, with no magical ingredients thrown in along the way. Weizenbaum's more important and defensible message was that we should not strive to create Strong AI and should be extremely cautious about the AI systems that we can create and have already created. As one might expect, the defensible thesis is a hybrid: *AI* (Strong AI) *is possible in principle but not desirable. The AI that's practically possible is not necessarily evil—unless it is mistaken for Strong AI!*

The gap between today's systems and the science-fictional systems dominating the popular imagination is still huge, though many folks, both lay and expert, manage to underestimate it. Let's consider IBM's Watson, which can stand as a worthy landmark for our imaginations for the time being. It is the result of a very large-scale R&D process extending over many person-centuries of intelligent design, and as George Church notes in these pages, it uses thousands of times more energy than a human brain (a technological limitation that, as he also notes, may be temporary). Its victory in *Jeopardy!* was a genuine triumph, made possible by the formulaic restrictions of the *Jeopardy!* rules, but in order for it to compete, even these rules had to be revised (one of

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[10] In *Darwin's Dangerous Idea,* 1995, p. 109, I coined the capitalized version, *Vast,* meaning *Very much more than ASTronomical*, and its complement, *Vanishing,* to replace the usual exaggerations *infinite* and *infinitesimal* for discussions of those possibilities that are not officially infinite but nevertheless infinite for all practical purposes.

[11] Aylin Caliskan-Islam, Joanna J. Bryson & Arvind Narayanan, "Semantics derived automatically from language corpora contain human-like biases," *Science,* 14 April 2017, 356: 6334, pp. 183-6. DOI: 10.1126/science.aal4230.

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those trade-offs: you give up a little versatility, a little humanity, and get a crowd-pleasing show). Watson is not good company, in spite of misleading ads from IBM that suggest a general conversational ability, and turning Watson into a plausibly multidimensional *agent* would be like turning a hand calculator into Watson. Watson could be a useful core faculty for such an agent, but more like a cerebellum or an amygdala than a mind—at best, a special-purpose subsystem that could play a big supporting role, but not remotely up to the task of framing purposes and plans and building insightfully on its conversational experiences.

Why would we want to create a thinking, creative agent out of Watson? Perhaps Turing's brilliant idea of an operational test has lured us into a trap: the quest to create at least the illusion of a real person behind the screen, bridging the "uncanny valley." The danger, here, is that ever since Turing posed his challenge—which was, after all, a challenge to *fool* the judges—AI creators have attempted to paper over the valley with cutesy humanoid touches, Disneyfication effects that will enchant and disarm the uninitiated. Weizenbaum's ELIZA was the pioneer example of such superficial illusion-making, and it was his dismay at the ease with which his laughably simple and shallow program could persuade people they were having a serious heart-to-heart conversation that first sent him on his mission.

He was right to be worried. If there is one thing we have learned from the restricted Turing Test competitions for the Loebner Prize, it is that even very intelligent people who aren't tuned in to the possibilities and shortcuts of computer programming are readily taken in by simple tricks. The attitudes of people in AI toward these methods of dissembling at the "user interface" have ranged from contempt to celebration, with a general appreciation that the tricks are not deep but can be potent. One shift in attitude that would be very welcome is a candid acknowledgment that humanoid embellishments are *false advertising*—something to condemn, not applaud.

How could that be accomplished? Once we recognize that people are starting to make life-or-death decisions largely on the basis of "advice" from AI systems whose inner operations are unfathomable in practice, we can see a good reason why those who in any way encourage people to put more trust in these systems than they warrant should be held morally and legally accountable. AI systems are very powerful tools—so powerful that even experts will have good reason not to trust their own judgment over the "judgments" delivered by their tools. But then, if these tool users are going to benefit, financially or otherwise, from driving these tools through *terra incognita,* they need to make sure they know how to do this responsibly, with maximum control and justification. Licensing and bonding operators, just as we license pharmacists (and crane operators!) and other specialists whose errors and misjudgments can have dire consequences, can, with pressure from insurance companies and other underwriters, oblige creators of AI systems to go to extraordinary lengths to search for and reveal weaknesses and gaps in their products, and to train those entitled to operate them.

One can imagine a sort of inverted Turing Test in which the judge is on trial; until he or she can spot the weaknesses, the overstepped boundaries, the gaps in a system, no license to operate will be issued. The mental training required to achieve certification as a judge will be demanding. The urge to adopt the intentional stance, our normal tactic whenever we encounter what seems to be an intelligent agent, is almost overpoweringly strong. Indeed, the capacity to resist the allure of treating an apparent person as a person

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is an ugly talent, reeking of racism or species-ism. Many people would find the cultivation of such a ruthlessly skeptical approach morally repugnant, and we can anticipate that even the most proficient system-users would occasionally succumb to the temptation to "befriend" their tools, if only to assuage their discomfort with the execution of their duties. No matter how scrupulously the AI designers launder the phony "human" touches out of their wares, we can expect novel habits of thought, conversational gambits and ruses, traps and bluffs to arise in this novel setting for human action. The comically long lists of known side effects of new drugs advertised on television will be dwarfed by the obligatory revelations of the sorts of questions that can*not* be responsibly answered by particular systems, with heavy penalties for those who "overlook" flaws in their products. It is widely noted that a considerable part of the growing economic inequality in today's world is due to the wealth accumulated by digital entrepreneurs; we should enact legislation that puts their deep pockets in escrow for the public good. Some of the deepest pockets are voluntarily out in front of these obligations to serve society first and make money secondarily, but we shouldn't rely on good will alone.

We don't need artificial conscious agents. There is a surfeit of natural conscious agents, enough to handle whatever tasks should be reserved for such special and privileged entities. We need intelligent tools. Tools do not have rights, and should not have feelings that could be hurt, or be able to respond with resentment to "abuses" rained on them by inept users.[12] One of the reasons for not making artificial conscious agents is that however autonomous they might become (and in principle, they can be as autonomous, as self-enhancing or self-creating, as any person), they would not—without special provision, which might be waived—share with us natural conscious agents our vulnerability or our mortality.

I once posed a challenge to students in a seminar at Tufts I co-taught with Matthias Scheutz on artificial agents and autonomy: Give me the specs for a robot that could sign a binding contract with you—not as a surrogate for some human owner but on its own. This isn't a question of getting it to understand the clauses or manipulate a pen on a piece of paper but of having and *deserving* legal status as a morally responsible agent. Small children can't sign such contracts, nor can those disabled people whose legal status requires them to be under the care and responsibility of guardians of one sort or another. The problem for robots who might want to attain such an exalted status is that, like Superman, they are too invulnerable to be able to make a credible promise. If they were to renege, what would happen? What would be the penalty for promise-breaking? Being locked in a cell or, more plausibly, dismantled? Being locked up is barely an inconvenience for an AI unless we first install artificial wanderlust that cannot be ignored or disabled by the AI on its own (and it would be systematically difficult to make this a foolproof solution, given the presumed cunning and self-knowledge of the AI); and dismantling an AI (either a robot or a bedridden agent like Watson) is not killing it, if the information stored in its design and software is preserved. The very ease of digital recording and transmitting—the breakthrough that permits software and data to be,

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[12] Joanna J. Bryson, "Robots Should Be Slaves," in *Close Engagement with Artificial Companions*, Yorick Wilks, ed., (Amsterdam, The Netherlands: John Benjamins, 2010), pp. 63-74; http://www.cs.bath.ac.uk/~jjb/ftp/Bryson-Slaves-Book09.html.
_____, "Patiency Is Not a Virtue: AI and the Design of Ethical Systems," https://www.cs.bath.ac.uk/~jjb/ftp/Bryson-Patiency-AAAISS16.pdf.

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in effect, immortal—removes robots from the world of the vulnerable (at least robots of the usually imagined sorts, with digital software and memories). If this isn't obvious, think about how human morality would be affected if we could make "backups" of people every week, say. Diving headfirst on Saturday off a high bridge without benefit of bungee cord would be a rush that you wouldn't remember when your Friday night backup was put online Sunday morning, but you could enjoy the videotape of your apparent demise thereafter.

So what we are creating are not—should not be—conscious, humanoid agents but an entirely new sort of entities, rather like oracles, with no conscience, no fear of death, no distracting loves and hates, no personality (but all sorts of foibles and quirks that would no doubt be identified as the "personality" of the system): boxes of truths (if we're lucky) almost certainly contaminated with a scattering of falsehoods. It will be hard enough learning to live with them without distracting ourselves with fantasies about the Singularity in which these AIs will enslave us, literally. The *human* use of human beings will soon be changed—once again—forever, but we can take the tiller and steer between some of the hazards if we take responsibility for our trajectory.

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The roboticist **Rodney Brooks,** *featured in Errol Morris's 1997 documentary* Fast, Cheap and Out of Control *along with a lion-tamer, a topiarist, and an expert on the naked mole rat, was described by one reviewer as "smiling with a wild gleam in his eye." But that's pretty much true of most visionaries.*

A few years later in his career, Brooks, as befits one of the world's leading roboticists, suggested that "we overanthropomorphize humans, who are after all mere machines." He went on to present a warm-hearted vision of a coming AI world in which "the distinction between us and robots is going to disappear." He also admitted to something of a divided worldview. "Like a religious scientist, I maintain two sets of inconsistent beliefs and act on each of them in different circumstances," he wrote. "It is this transcendence between belief systems that I think will be what enables mankind to ultimately accept robots as emotional machines, and thereafter start to empathize with them and attribute free will, respect, and ultimately rights to them."

That was in 2002. In these pages, he takes a somewhat more jaundiced, albeit narrower, view; he is alarmed by the extent to which we have come to rely on pervasive systems that are not just exploitative but also vulnerable, as a result of the too-rapid development of software engineering—an advance that seems to have outstripped the imposition of reliably effective safeguards.

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THE INHUMAN MESS OUR MACHINES HAVE GOTTEN US INTO

Rodney Brooks

Rodney Brooks *is a computer scientist; Panasonic Professor of Robotics, emeritus, MIT; former director, MIT Computer Science Lab; and founder, chairman, and CTO of Rethink Robotics. He is the author of* Flesh and Machines.

Mathematicians and scientists are often limited in how they see the big picture, beyond their particular field, by the tools and metaphors they use in their work. Norbert Wiener is no exception, and I might guess that neither am I.

When he wrote *The Human Use of Human Beings,* Wiener was straddling the end of the era of understanding machines and animals simply as physical processes and the beginning of our current era of understanding machines and animals as computational processes. I suspect there will be future eras whose tools will look as distinct from the tools of the two eras Wiener straddled as those tools did from each other.

Wiener was a giant of the earlier era and built on the tools developed since the time of Newton and Leibniz to describe and analyze continuous processes in the physical world. In 1948 he published *Cybernetics,* a word he coined to describe the science of communication and control in both machines and animals. Today we would refer to the ideas in this book as control theory, an indispensable discipline for the design and analysis of physical machines, while mostly neglecting Wiener's claims about the science of communication. Wiener's innovations were largely driven by his work during the Second World War on mechanisms to aim and fire anti-aircraft guns. He brought mathematical rigor to the design of the sorts of technology whose design processes had been largely heuristic in nature: from the Roman waterworks through Watt's steam engine to the early development of automobiles.

One can imagine a different contingent version of our intellectual and technological history had Alan Turing and John von Neumann, both of whom made major contributions to the foundations of computing, not appeared on the scene. Turing contributed a fundamental model of computation—now known as a Turing Machine—in his paper "On Computable Numbers with an Application to the Entscheidungsproblem," written and revised in 1936 and published in 1937. In these machines, a linear tape of symbols from a finite alphabet encodes the input for a computational problem and also provides the working space for the computation. A different machine was required for each separate computational problem; later work by others would show that in one particular machine, now known as a Universal Turing Machine, an arbitrary set of computing instructions could be encoded on that same tape.

In the 1940s, von Neumann developed an abstract self-reproducing machine called a cellular automaton. In this case it occupied a finite subset of an infinite two-dimensional array of squares each containing a single symbol from a finite alphabet of twenty-nine distinct symbols—the rest of the infinite array starts out blank. The single symbols in each square change in lockstep, based on a complex but finite rule about the current symbol in that square and its immediate neighbors. Under the complex rule that von Neumann developed, most of the symbols in most of the squares stay the same and a few change at each step. So when one looks at the non-blank squares, it appears that

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there is a constant structure with some activity going on inside it. When von Neumann's abstract machine reproduced, it made a copy of itself in another region of the plane. Within the "machine" was a horizontal line of squares which acted as a finite linear tape, using a subset of the finite alphabet. It was the symbols in those squares that encoded the machine of which they were a part. During the machine's reproduction, the "tape" could move either left or right and was both interpreted (transcribed) as the instructions (translation) for the new "machine" being built and then copied (replicated)—with the new copy being placed inside the new machine for further reproduction. Francis Crick and James Watson later showed, in 1953, how such a tape could be instantiated in biology by a long DNA molecule with its finite alphabet of four nucleobases: guanine, cytosine, adenine, and thymine (G, C, A, and T).[13] As in von Neumann's machine, in biological reproduction the linear sequence of symbols in DNA is interpreted—through transcription into RNA molecules, which then are translated into proteins, the structures that make up a new cell—and the DNA is replicated and encased in the new cell.

A second foundational piece of work was in a 1945 "First Draft" report on the design for a digital computer, wherein von Neumann advocated for a memory that could contain both instructions and data.[14] This is now known as a von Neumann architecture computer—as distinct from a Harvard architecture computer, where there are two separate memories, one for instructions and one for data. The vast majority of computer chips built in the era of Moore's Law are based on the von Neumann architecture, including those powering our data centers, our laptops, and our smartphones. Von Neumann's digital-computer architecture is conceptually the same generalization—from early digital computers constructed with electromagnetic relays at both Harvard University and Bletchley Park—that occurs in going from a special-purpose Turing Machine to a Universal Turing Machine. Furthermore, his self-replicating automata share a fundamental similarity with both the construction of a Turing Machine and the mechanism of DNA-based reproducing biological cells. There is to this day scholarly debate over whether von Neumann saw the cross connections between these three pieces of work, Turing's and his two. Turing's revision of his paper was done while he and von Neumann were both at Princeton; indeed, after getting his PhD, Turing almost stayed on as von Neumann's postdoc.

Without Turing and von Neumann, the cybernetics of Wiener might have remained a dominant mode of thought and driver of technology for much longer than its brief moment of supremacy. In this imaginary version of history, we might well live today in an actual steam-punk world and not just get to observe its fantastical instantiations at Maker Faires!

My point is that Wiener thought about the world—physical, biological, and (in *Human Use*) sociological—in a particular way. He analyzed the world as continuous variables, as he explains in chapter 1 along with a nod to thermodynamics through an overlay of Gibbs statistics. He also shoehorns in a weak and unconvincing model of information as message-passing between and among both physical and biological entities. To me, and from today's vantage point seventy years on, his tools seem woefully

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[13] "A Structure for Deoxyribose Nucleic Acid," *Nature* 171, 737–738 (1953).

[14] https://en.wikipedia.org//wiki/First_Draft_of_a_Report_on_the_EDVAC#Controversy. Von Neumann is listed as the only author, whereas others contributed to the concepts he laid out; thus credit for the architecture has gone to him alone.

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inadequate for describing the mechanisms underlying biological systems, and so he missed out on how similar mechanisms might eventually be embodied in technological computational systems—as now they have been. Today's dominant technologies were developed in the world of Turing and von Neumann, rather than the world of Wiener.

In the first industrial revolution, energy from a steam engine or a water wheel was used by human workers to replace their own energy. Instead of being a source of energy for physical work, people became modulators of how a large source of energy was used. But because steam engines and water wheels had to be large to be an efficient use of capital, and because in the 18th century the only technology for spatial distribution of energy was mechanical and worked only at very short range, many workers needed to be crowded around the source of energy. Wiener correctly argues that the ability to transmit energy as electricity caused a second industrial revolution. Now the source of energy could be distant from where it was used, and from the beginning of the 20th century, manufacturing could be much more dispersed as electrical-distribution grids were built.

Wiener then argues that a further new technology, that of the nascent computational machines of his time, will provide yet another revolution. The machines he talks about seem to be both analog and (perhaps) digital in nature; and he points out, in *The Human Use of Human Beings*, that since they will be able to make decisions, both blue-collar and white-collar workers may be reduced to being mere cogs in a much bigger machine. He fears that humans might use and abuse one another through organizational structures that this capability will encourage. We have certainly seen this play out in the last sixty years, and that disruption is far from over.

However, his physics-based view of computation protected him from realizing just how bad things might get. He saw machines' ability to communicate as providing a new and more inhuman way of exerting command and control. He missed that within a few decades computation systems would become more like biological systems, and it seems, from his descriptions in chapter 10 of his own work on modeling some aspects of biology, that he woefully underappreciated the many orders of magnitude of further complexity of biology over physics. We are in a much more complex situation today than he foresaw, and I am worried that it is much more pernicious than even his worst imagined fears.

In the 1960s, computation became firmly based on the foundations set out by Turing and von Neumann, and it was digital computation, based on the idea of finite alphabets which they both used. An arbitrarily long sequence, or string, formed by characters from a finite alphabet, can be encoded as a unique integer. As with Turing Machines themselves, the formalism for computation became that of computing an integer-valued function of a single integer-valued input.

Turing and von Neumann both died in the 1950s and at that time this is how they saw computation. Neither foresaw the exponential increase in computing capability that Moore's Law would bring—nor how pervasive computing machinery would become. Nor did they foresee two developments in our modeling of computation, each of which poses a great threat to human society.

The first is rooted in the abstractions they adopted. In the fifty-year, Moore's Law–fueled race to produce software that could exploit the doubling of computer capability every two years, the typical care and certification of engineering disciplines was thrown by the wayside. Software engineering was fast and prone to failures. This

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rapid development of software without standards of correctness has opened up many routes to exploit von Neumann architecture's storage of data and instructions in the same memory. One of the most common routes, known as "buffer overrun," involves an input number (or long string of characters) that is bigger than the programmer expected and overflows into where the instructions are stored. By carefully designing an input number that is too big by far, someone using a piece of software can infect it with instructions not intended by the programmer, and thus change what it does. This is the basis for creating a computer virus—so named for its similarity to a biological virus. The latter injects extra DNA into a cell, and that cell's transcription and translation mechanism blindly interprets it, making proteins that may be harmful to the host cell. Furthermore, the replication mechanism for the cell takes care of multiplying the virus. Thus, a small foreign entity can take control of a much bigger entity and bend its behavior in unexpected ways.

These and other forms of digital attacks have taken the security of our everyday lives from us. We rely on computers for almost everything now. We rely on computers for our infrastructure of electricity, gas, roads, cars, trains, and airplanes; these are all vulnerable. We rely on computers for our banking, our payment of bills, our retirement accounts, our mortgages, our purchasing of goods and services—these, too, are all vulnerable. We rely on computers for our entertainment, our communications both business and personal, our physical security at home, our information about the world, and our voting systems—all vulnerable. None of this will get fixed anytime soon. In the meantime, many aspects of our society are open to vicious attacks, whether by freelancing criminals or nation-state adversaries.

The second development is that computation has gone beyond simply computing functions. Instead, programs remain online continuously, and so they can gather data about a sequence of queries. Under the Wiener/Turing/von Neumann scheme, we might think of the communication pattern for a Web browser to be:

User: Give me Web page A.
Browser: Here is Web page A.
…
User: Give me Web page B.
Browser: Here is Web page B.

Now instead it can look like this:

User: Give me Web page A.
Browser: Here is Web page A. [And I will secretly remember that you asked for Web page A.]
...
User: Give me Web page B.
Browser: Here is Web page B. [I see a correlation between its contents and that of the earlier requested Web page A, so I will update my model of you, the user, and transmit it to the company that produced me.]

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When the machine no longer simply computes a function but instead maintains a state, it can start to make inferences about the human by the sequence of requests presented to it. And when different programs correlate across different request streams—say, correlating Web-page searches with social-media posts, or the payment for services on another platform, or the dwell time on a particular advertisement, or where the user has walked or driven with their GPS-enabled smartphone—the total systems of many programs communicating with one another and with databases leads to a whole new loss of privacy. The great exploitative leap made by so many West Coast companies has been to monetize those inferences without the knowing permission of the person generating the interactions with the computing machine platforms.

Wiener, Turing, and von Neumann could not foresee the complexity of those platforms, wherein the legal mumbo-jumbo of the terms-of-use contracts the humans willingly enter into, without an inkling of what they entail, leads them to give up rights they would never concede in a one-on-one interaction with another human being. The computation platforms have become a shield behind which some companies hide in order to inhumanly exploit others. In certain other countries, the governments carry out these manipulations, and there the goal is not profits but the suppression of dissent.

Humankind has gotten itself into a fine pickle: We are being exploited by companies that paradoxically deliver services we crave, and at the same time our lives depend on many software-enabled systems that are open to attack. Getting ourselves out of this mess will be a long-term project. It will involve engineering, legislation, and most important, moral leadership. Moral leadership is the first and biggest challenge.

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I first met **Frank Wilczek** *in the 1980s, when he invited me to his home in Princeton to talk about anyons. "The address is 112 Mercer Street," he wrote. "Look for the house with no driveway." So there I was, a few hours later, in Einstein's old living room, talking to a future recipient of the Nobel Prize in physics. If Frank was as impressed as I was by the surroundings, you'd never guess it. His only comment concerned the difficulty of finding a parking place in front of a "house with no driveway."*

Unlike most theoretical physicists, Frank has long had a keen interest in AI, as witnessed in these three "Observations":

1. "Francis Crick called it 'the Astonishing Hypothesis': that consciousness, also known as Mind, is an emergent property of matter," which, if true, indicates that "all intelligence is machine intelligence. What distinguishes natural from artificial intelligence is not what it is, but only how it is made."

2. "Artificial intelligence is not the product of an alien invasion. It is an artifact of a particular human culture and reflects the values of that culture."

3. "David Hume's striking statement 'Reason Is, and Ought only to Be, the Slave of the Passions' was written in 1738 [and] was, of course, meant to apply to human reason and human passions. . . . But Hume's logical/philosophical point remains valid for AI. Simply put: Incentives, not abstract logic, drive behavior."

He notes that "the big story of the 20th and the 21st century is that [as] computing develops, we learn how to calculate the consequences of the [fundamental] laws better and better. There's also a feedback cycle: When you understand matter better, you can design better computers, which will enable you to calculate better. It's kind of an ascending helix."

Here he argues that human intelligence, for now, holds the advantage—yet our future, unbounded by our solar system and doubtless also by our galaxy, will never be realized without the help of our AIs.

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THE UNITY OF INTELLIGENCE
Frank Wilczek

Frank Wilczek *is Herman Feshbach Professor of Physics at MIT, recipient of the 2004 Nobel Prize in physics, and the author of* A Beautiful Question: Finding Nature's Deep Design.

I. A Simple Answer to Contentious Questions:

- Can an artificial intelligence be conscious?
- Can an artificial intelligence be creative?
- Can an artificial intelligence be evil?

Those questions are often posed today, both in popular media and in scientifically informed debates. But the discussions never seem to converge. Here I'll begin by answering them as follows:

Based on physiological psychology, neurobiology, and physics, it would be very surprising if the answers were not Yes, Yes, and Yes. The reason is simple, yet profound: Evidence from those fields makes it overwhelmingly likely that there is no sharp divide between natural and artificial intelligence.

In his 1994 book of that title, the renowned biologist Francis Crick proposed an "astonishing hypothesis": that mind emerges from matter. He famously claimed that mind, in all its aspects, is "no more than the behavior of a vast assembly of nerve cells and their associated molecules."

The "astonishing hypothesis" is in fact the foundation of modern neuroscience. People try to understand how minds work by understanding how brains function; and they try to understand how brains function by studying how information is encoded in electrical and chemical signals, transformed by physical processes, and used to control behavior. In that scientific endeavor, they make no allowance for extraphysical behavior. So far, in thousands of exquisite experiments, that strategy has never failed. It has never proved necessary to allow for the influence of consciousness or creativity unmoored from brain activity to explain any observed fact of psychophysics or neurobiology. No one has ever stumbled upon a power of mind which is separate from conventional physical events in biological organisms. While there are many things we do not understand about brains, and about minds, the "astonishing hypothesis" has held intact.

If we broaden our view beyond neurobiology to consider the whole range of scientific experimentation, the case becomes still more compelling. In modern physics, the foci of interest are often extremely delicate phenomena. To investigate them, experimenters must take many precautions against contamination by "noise." They often find it necessary to construct elaborate shielding against stray electric and magnetic fields; to compensate for tiny vibrations due to micro-earthquakes or passing cars; to work at extremely low temperatures and in high vacuum, and so forth. But there's a notable exception: They have never found it necessary to make allowances for what people nearby (or, for that matter, far away) are thinking. No "thought waves," separate from known physical processes yet capable of influencing physical events, seem to exist.

That conclusion, taken at face value, erases the distinction between natural and artificial intelligence. It implies that if we were to duplicate, or accurately simulate, the physical processes occurring in a brain—as, in principle, we can—and wire up its input

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and output to sense organs and muscles, then we would reproduce, in a physical artifact, the observed manifestations of natural intelligence. Nothing observable would be missing. As an observer, I'd have no less (and no more) reason to ascribe consciousness, creativity, or evil to that artifact than I do to ascribe those properties to its natural counterparts, like other human beings.

Thus, by combining Crick's "astonishing hypothesis" in neurobiology with powerful evidence from physics, we deduce that natural intelligence is a special case of artificial intelligence. That conclusion deserves a name, and I will call it "the astonishing corollary."

With that, we have the answer to our three questions. Since consciousness, creativity, and evil are obvious features of natural human intelligence, they are possible features of artificial intelligence.

A hundred years ago, or even fifty, to believe the hypothesis that mind emerges from matter, and to infer our corollary that natural intelligence is a special case of artificial intelligence, would have been leaps of faith. In view of the many surrounding gaps—chasms, really—in contemporary understanding of biology and physics, they were genuinely doubtful propositions. But epochal developments in those areas have changed the picture:

In biology: A century ago, not only thought but also metabolism, heredity, and perception were deeply mysterious aspects of life that defied physical explanation. Today, of course, we have extremely rich and detailed accounts of metabolism, heredity, and many aspects of perception, from the bottom up, starting at the molecular level.

In physics: After a century of quantum physics and its application to materials, physicists have discovered, over and over, how rich and strange the behavior of matter can be. Superconductors, lasers, and many other wonders demonstrate that large assemblies of molecular units, each simple in itself, can exhibit qualitatively new, "emergent" behavior, while remaining fully obedient to the laws of physics. Chemistry, including biochemistry, is a cornucopia of emergent phenomena, all now quite firmly grounded in physics. The pioneering physicist Philip Anderson, in an essay titled "More Is Different," offers a classic discussion of emergence. He begins by acknowledging that "the reductionist hypothesis [i.e., the completeness of physical explanations based on known interactions of simple parts] may still be a topic for controversy among philosophers, but among the great majority of active scientists I think it is accepted without question." But he goes on to emphasize that "[t]he behavior of large and complex aggregates of elementary particles, it turns out, is not to be understood in terms of a simple extrapolation of the properties of a few particles."[15] Each new level of size and complexity supports new forms of organization, whose patterns encode information in new ways and whose behavior is best described using new concepts.

Electronic computers are a magnificent example of emergence. Here, all the cards are on the table. Engineers routinely design, from the bottom up, based on known (and quite sophisticated) physical principles, machines that process information in extremely impressive ways. Your iPhone can beat you at chess, quickly collect and deliver information about anything, and take great pictures, too. Because the process whereby computers, smartphones, and other intelligent objects are designed and manufactured is completely transparent, there can be no doubt that their wonderful

[15] *Science,* 4 August 1972, Vol. 177, No. 4047, pp. 393-96.

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capabilities emerge from regular physical processses, which we can trace down to the level of electrons, photons, quarks, and gluons. Evidently, brute matter can get pretty smart.

Let me summarize the argument. From two strongly supported hypotheses, we've drawn a straightforward conclusion:

- Human mind emerges from matter.
- Matter is what physics says it is.
- *Therefore,* the human mind emerges from physical processes we understand and can reproduce artificially.
- *Therefore,* natural intelligence is a special case of artificial intelligence.

Of course, our "astonishing corollary" could fail; the first two lines of this argument are hypotheses. But their failure would have to bring in a foundation-shattering discovery—a significant new phenomenon, with large-scale physical consequences, which takes place in unremarkable, well-studied physical circumstances (i.e., the materials, temperatures, and pressures inside human brains) yet which has somehow managed for many decades to elude determined investigators armed with sophisticated instruments. Such a discovery would be. . . astonishing.

II. The Future of Intelligence

It is part of human nature to improve on human bodies and minds. Historically, clothing, eyeglasses, and watches are examples of increasingly sophisticated augmentations that enhance our toughness, perception, and awareness. They are major improvements to the natural human endowment, whose familiarity should not blind us to their depth. Today smartphones and the Internet are bringing the human drive toward augmentation into realms more central to our identity as intelligent beings. They are giving us, in effect, quick access to a vast collective awareness and a vast collective memory.

At the same time, autonomous artificial intelligences have become world champions in a wide variety of "cerebral" games, such as chess and Go, and have taken over many sophisticated pattern-recognition tasks, such as reconstructing what happened during complex reactions at the Large Hadron Collider from a blizzard of emerging particle tracks, to find new particles; or gathering clues from fuzzy X-ray, fMRI, and other types of images, to diagnose medical problems.

Where is this drive toward self-enhancement and innovation taking us? While the precise sequence of events and the timescale over which they'll play out is impossible to predict (or, at least, beyond me), some basic considerations suggest that eventually the most powerful embodiments of mind will be quite different things from human brains as we know them today.

Consider six factors whereby information-processing technology exceeds human capabilities—vastly, qualitatively, or both:

- *Speed:* The orchestrated motion of electrons, which is the heart of modern artificial information-processing, can be much faster than the processes of diffusion and chemical change by which brains operate. Typical modern computer clock rates approach 10 gigahertz, corresponding to 10 billion operations per second. No single measure of speed applies to the bewildering variety of brain processes, but one fundamental limitation is latency of action

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potentials, which limits their spacing to a few 10s per second. It is probably no accident that the "frame rate," at which we can distinguish that movies are actually a sequence of stills, is about 40 per second. Thus, electronic processing is close to a billion times faster.

- *Size:* The linear dimension of a typical neuron is about 10 microns. Molecular dimensions, which set a practical limit, are about 10,000 times smaller, and artificial processing units are approaching that scale. Smallness makes communication more efficient.
- *Stability:* Whereas human memory is essentially continuous (analog), artificial memory can incorporate discrete (digital) features. Whereas analog quantities can erode, digital quantities can be stored, refreshed, and maintained with complete accuracy.
- *Duty Cycle:* Human brains grow tired with effort. They need time off to take nourishment and to sleep. They carry the burden of aging. Most profoundly: They die.
- *Modularity* (open architecture): Because artificial information processors can support precisely defined digital interfaces, they can readily assimilate new modules. Thus, if we want a computer to "see" ultraviolet or infrared or "hear" ultrasound, we can feed the output from an appropriate sensor directly into its "nervous system." The architecture of brains is much more closed and opaque, and the human immune system actively resists implants.
- *Quantum readiness*: One case of modularity deserves special mention, because of its long-term potential. Recently physicists and information scientists have come to appreciate that the principles of quantum mechanics support new computing principles, which can empower qualitatively new forms of information processing and (plausibly) new levels of intelligence. But these possibilities rely on aspects of quantum behavior which are quite delicate and seem especially unsuitable for interfacing with the warm, wet, messy enviroment of human brains.

Evidently, as platforms for intelligence, human brains are far from optimal. Still, although versatile housekeeping robots or mechanical soldiers would find ready, lucrative markets, at present there is no machine that approaches the kind of general-purpose human intelligence those applications would require. Despite their relative weakness on many fronts, human brains have some big advantages over their artificial competitors. Let me mention five:

- *Three-dimensionality:* Although, as noted, the linear dimensions of existing artificial processing units are vastly smaller than those of brains, the procedure by which they're made—centered on lithography (basically, etching)—is essentially two-dimensional. That is revealed visibly in the geometry of computer boards and chips. Of course, one can stack boards, but the spacing between layers is much larger, and communication much less efficient, than within layers. Brains make better use of all three dimensions.
- *Self-repair:* Human brains can recover from, or work around, many kinds of injuries or errors. Computers often must be repaired or rebooted externally.

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- *Connectivity:* Human neurons typically support several hundred connections (synapses). Moreover, the complex pattern of these connections is very meaningful. (See our next point.) Computer units typically make only a handful of connections, in regular, fixed patterns.
- *Development* (self-assembly with interactive sculpting): The human brain grows its units by cell divisions and orchestrates them into coherent structures by movement and folding. It also proliferates an abundance of connections among the cells. An important part of its sculpting occurs through active processes during infancy and childhood, as the individual interacts with his or her environment. In this process, many connections are winnowed away, while others are strengthened, depending on their effectiveness in use. Thus, the fine structure of the brain is tuned through interaction with the external world—a rich source of information and feedback!
- *Integration* (sensors and actuators): The human brain comes equipped with a variety of sensory organs, notably including its outgrowth eyes, and with versatile actuators, including hands that build, legs that walk, and mouths that speak. Those sensors and actuators are seamlessy integrated into the brain's information-processing centers, having been honed over millions of years of natural selection. We interpret their raw signals and control their large-scale actions with minimal conscious attention. The flip side is that we don't know how we do it, and the implementation is opaque. It's proving surprisingly difficult to reach human standards on these "routine" input-output functions.

These advantages of human brains over currently engineered artifacts are profound. Human brains supply an inspiring existence proof, showing us several ways we can get more out of matter. When, if ever, will our engineering catch up?

I don't know for sure, but let me offer some informed opinions. The challenges of three-dimensionality and, to a lesser extent, self-repair don't look overwhelming. They present some tough engineering problems, but many incremental improvements are easy to imagine, and there are clear paths forward. And while the powers of human eyes, hands, and other sensory organs and actuators are wonderfully effective, their abilities are far from exhausting any physical limits. Optical systems can take pictures with higher resolution in space, time, and color, and in more regions of the electromagnetic spectrum; robots can move faster and be stronger; and so forth. In these domains, the components necessary for superhuman performance, along many axes, are already available. The bottleneck is getting information into and out of them, rapidly, in the language of the information-processing units.

And this brings us to the remaining, and I think most profound, advantages of brains over artificial devices, which stem from their connectivity and interactive development. Those two advantages are synergistic, since it is interactive development that sculpts the massively wired but sprawling structure of the infant brain, enabled by exponential growth of neurons and synapses, to get tuned into the extraordinary instrument it becomes. Computer scientists are beginning to discover the power of the brain's architecture: Neural nets, whose basic design, as their name suggests, was directly inspired by the brain's, have scored some spectacular successes in game playing and pattern recognition, as noted. But present-day engineering has nothing comparable—in

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the (currently) esoteric domain of self-reproducing machines—to the power and versatility of neurons and their synapses. This could become a new, great frontier of research. Here too, biology might point the way, as we come to understand biological development well enough to imitate its essence.

Altogether, the advantages of artificial over natural intelligence appear permanent, while the advantages of natural over artificial intelligence, though substantial at present, appear transient. I'd guess that it will be many decades before engineering catches up, but—barring catastrophic wars, climate change, or plagues, so that technological progress stays vigorous—few centuries.

If that's right, we can look forward to several generations during which humans, empowered and augmented by smart devices, coexist with increasingly capable autonomous AIs. There will be a complex, rapidly changing ecology of intelligence, and rapid evolution in consequence. Given the intrinsic advantages that engineered devices will eventually offer, the vanguard of that evolution will be cyborgs and superminds, rather than lightly adorned *Homo sapiens.*

Another important impetus will come from the exploration of hostile environments, both on Earth (e.g., the deep ocean) and, especially, in space. The human body is poorly adapted to conditions outside a narrow band of temperatures, pressures, and atmospheric composition. It needs a wide variety of specific, complex nutrients, and plenty of water. Also, it is not radiation-hardened. As the manned space program has amply demonstrated, it is difficult and expensive to maintain humans outside their terrestrial comfort zone. Cyborgs or autonomous AIs could be much more effective in these explorations. Quantum AIs, with their sensitivity to noise, might even be happier in the cold and dark of deep space.

In a moving passage from his 1935 novel *Odd John,* science fiction's singular genius Olaf Stapledon has his hero, a superhuman (mutant) intelligence, describe *Homo sapiens* as "the Archaeopteryx of the spirit." He says this, fondly, to his friend and biographer, who is a normal human. Archaeopteryx was a noble creature, and a bridge to greater ones.

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I was introduced to **Max Tegmark** *some years ago by his MIT colleague Alan Guth, the father of the inflationary universe. A distinguished theoretical physicist and cosmologist himself, Max's principal concern nowadays is the looming existential risk posed by the creation of an AGI (artificial general intelligence—that is, one that matches human intelligence). Four years ago, Max co-founded, with Jaan Tallinn and others, the Future of Life Institute (FLI), which bills itself as "an outreach organization working to ensure that tomorrow's most powerful technologies are beneficial for humanity." While on a book tour in London, he was in the midst of planning for FLI, and he admits being driven to tears in a tube station after a trip to the London Science Museum, with its exhibitions spanning the gamut of humanity's technological achievements. Was all that impressive progress in vain?*

FLI's scientific advisory board includes Elon Musk, Frank Wilczek, George Church, Stuart Russell, and the Oxford philosopher Nick Bostrom, who dreamed up an oft-quoted Gedankenexperiment *that results in a world full of paper clips and nothing else, produced by an (apparently) well-meaning AGI who was just following orders. The Institute sponsors conferences (Puerto Rico 2015, Asilomar 2017) on AI safety issues and in 2018 instituted a grants competition focusing on research in aid of maximizing the societal benefits of AGI.*

While Max is sometimes listed—by the non-cognoscenti—on the side of the scaremongers, he believes, like Frank Wilczek, in a future that will immensely benefit from AGI if, in the attempt to create it, we can keep the human species from being sidelined.

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LET'S ASPIRE TO MORE THAN MAKING OURSELVES OBSOLETE

Max Tegmark

***Max Tegmark** is an MIT physicist and AI researcher; president of the Future of Life Institute; scientific director of the Foundational Questions Institute; and the author of* Our Mathematical Universe *and* Life 3.0: Being Human in the Age of Artificial Intelligence.

Although there's great controversy about how and when AI will impact humanity, the situation is clearer from a cosmic perspective: The technology-developing life that has evolved on Earth is rushing to make itself obsolete without devoting much serious thought to the consequences. This strikes me as embarrassingly lame, given that we can create amazing opportunities for humanity to flourish like never before, if we dare to steer a more ambitious course.

13.8 billion years after its birth, our Universe has become aware of itself. On a small blue planet, tiny conscious parts of our Universe have discovered that what they once thought was the sum total of existence was a minute part of something far grander: a solar system in a galaxy in a universe with over 100 billion other galaxies, arranged into an elaborate pattern of groups, clusters, and superclusters.

Consciousness is the cosmic awakening; it transformed our Universe from a mindless zombie with no self-awareness into a living ecosystem harboring self-reflection, beauty, hope, meaning, and purpose. Had that awakening never taken place, our Universe would have been pointless—a gigantic waste of space. Should our Universe go back to sleep permanently due to some cosmic calamity or self-inflicted mishap, it will become meaningless again.

On the other hand, things could get even better. We don't yet know whether we humans are the only stargazers in the cosmos, or even the first, but we've already learned enough about our Universe to know that it has the potential to wake up much more fully than it has thus far. AI pioneers such as Norbert Wiener have taught us that a further awakening of our Universe's ability to process and experience information need not require eons of additional evolution but perhaps mere decades of human scientific ingenuity.

We may be like that first glimmer of self-awareness you experienced when you emerged from sleep this morning, a premonition of the much greater consciousness that would arrive once you opened your eyes and fully awoke. Perhaps artificial superintelligence will enable life to spread throughout the cosmos and flourish for billions or trillions of years, and perhaps this will be because of decisions we make here, on our planet, in our lifetime.

Or humanity may soon go extinct, through some self-inflicted calamity caused by the power of our technology growing faster than the wisdom with which we manage it.

The evolving debate about AI's societal impact

Many thinkers dismiss the idea of superintelligence as science fiction, because they view intelligence as something mysterious that can exist only in biological organisms—especially humans—and as fundamentally limited to what today's humans can do. But from my perspective as a physicist, intelligence is simply a certain kind of information

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processing performed by elementary particles moving around, and there's no law of physics that says one can't build machines more intelligent in every way than we are, and able to seed cosmic life. This suggests that we've seen just the tip of the intelligence iceberg; there's an amazing potential to unlock the full intelligence latent in nature and use it to help humanity flourish—or flounder.

Others, including some of the authors in this volume, dismiss the building of an AGI (Artificial General Intelligence—an entity able to accomplish any cognitive task at least as well as humans) not because they consider it physically impossible but because they deem it too difficult for humans to pull off in less than a century. Among professional AI researchers, both types of dismissal have become minority views because of recent breakthroughs. There is a strong expectation that AGI will be achieved within a century, and the median forecast is only decades away. A recent survey of AI researchers by Vincent Muller and Nick Bostrom concludes:

> [T]he results reveal a view among experts that AI systems will probably (over 50%) reach overall human ability by 2040-50, and very likely (with 90% probability) by 2075. From reaching human ability, it will move on to superintelligence in 2 years (10%) to 30 years (75%) thereafter.[16]

In the cosmic perspective of gigayears, it makes little difference whether AGI arrives in thirty or three hundred years, so let's focus on the implications rather than the timing.

First, we humans discovered how to replicate some natural processes with machines, making our own heat, light, and mechanical horsepower. Gradually we realized that our bodies were also machines, and the discovery of nerve cells blurred the boundary between body and mind. Finally, we started building machines that could outperform not only our muscles but our minds as well. We've now been eclipsed by machines in the performance of many narrow cognitive tasks, ranging from memorization and arithmetic to game play, and we are in the process of being overtaken in many more, from driving to investing to medical diagnosing. If the AI community succeeds in its original goal of building AGI, then we will have, by definition, been eclipsed at all cognitive tasks.

This begs many obvious questions. For example, will whoever or whatever controls the AGI control Earth? Should we aim to control superintelligent machines? If not, can we ensure that they understand, adopt, and retain human values? As Norbert Wiener put it in *The Human Use of Human Beings:*

> Woe to us if we let [the machine] decide our conduct, unless we have previously examined the laws of its action, and know fully that its conduct will be carried out on principles acceptable to us! On the other hand, the machine . . . , which can learn and can make decisions on the basis of its learning, will in no way be obliged to make such decisions as we should have made, or will be acceptable to us.

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[16] Vincent C. Müller & Nick Bostrom, "Future Progress in Artificial Intelligence: A Survey of Expert Opinion," in *Fundamental Issues of Artificial Intelligence*, Vincent C. Muller, ed. (Springer International Publishing Switzerland, 2016), pp. 555-72. https://nickbostrom.com/papers/survey.pdf.

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And who are the "us"? Who should deem "such decisions . . . acceptable"? Even if future powers decide to help humans survive and flourish, how will we find meaning and purpose in our lives if we aren't needed for anything?

The debate about the societal impact of AI has changed dramatically in the last few years. In 2014, what little public talk there was of AI risk tended to be dismissed as Luddite scaremongering, for one of two logically incompatible reasons:

(1) AGI was overhyped and wouldn't happen for at least another century.

(2) AGI would probably happen sooner but was virtually guaranteed to be beneficial.

Today, talk of AI's societal impact is everywhere, and work on AI safety and AI ethics has moved into companies, universities, and academic conferences. The controversial position on AI safety research is no longer to advocate for it but to dismiss it. Whereas the open letter that emerged from the 2015 Puerto Rico AI conference (and helped mainstream AI safety) spoke only in vague terms about the importance of keeping AI beneficial, the 2017 Asilomar AI Principles (see below) had real teeth: They explicitly mention recursive self-improvement, superintelligence, and existential risk, and were signed by AI industry leaders and over a thousand AI researchers from around the world.

Nonetheless, most discussion is limited to the near-term impact of narrow AI and the broader community pays only limited attention to the dramatic transformations that AGI may soon bring to life on Earth. Why?

Why we're rushing to make ourselves obsolete, and why we avoid talking about it

First of all, there's simple economics. Whenever we figure out how to make another type of human work obsolete by building machines that do it better and cheaper, most of society gains: Those who build and use the machines make profits, and consumers get more affordable products. This will be as true of future investor AGIs and scientist AGIs as it was of weaving machines, excavators, and industrial robots. In the past, displaced workers usually found new jobs, but this basic economic incentive will remain even if that is no longer the case. The existence of affordable AGI means, by definition, that *all* jobs can be done more cheaply by machines, so anyone claiming that "people will always find new well-paying jobs" is in effect claiming that AI researchers will fail to build AGI.

Second, *Homo sapiens* is by nature curious, which will motivate the scientific quest for understanding intelligence and developing AGI even without economic incentives. Although curiosity is one of the most celebrated human attributes, it can cause problems when it fosters technology we haven't yet learned how to manage wisely. Sheer scientific curiosity without profit motive contributed to the discovery of nuclear weapons and tools for engineering pandemics, so it's not unthinkable that the old adage "Curiosity killed the cat" will turn out to apply to the human species as well.

Third, we're mortal. This explains the near unanimous support for developing new technologies that help us live longer, healthier lives, which strongly motivates current AI research. AGI can clearly aid medical research even more. Some thinkers even aspire to near immortality via cyborgization or uploading.

We're thus on the slippery slope toward AGI, with strong incentives to keep sliding downward, even though the consequence will by definition be our economic obsolescence. We will no longer be needed for anything, because all jobs can be done

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more efficiently by machines. The successful creation of AGI would be the biggest event in human history, so why is there so little serious discussion of what it might lead to?

Here again, the answer involves multiple reasons.

First, as Upton Sinclair famously quipped, "It is difficult to get a man to understand something, when his salary depends on his not understanding it."[17] For example, spokesmen for tech companies or university research groups often claim there are no risks attached to their activities even if they privately think otherwise. Sinclair's observation may help explain not only reactions to risks from smoking and climate change but also why some treat technology as a new religion whose central articles of faith are that more technology is always better and whose heretics are clueless scaremongering Luddites.

Second, humans have a long track record of wishful thinking, flawed extrapolation of the past, and underestimation of emerging technologies. Darwinian evolution endowed us with powerful fear of concrete threats, not of abstract threats from future technologies that are hard to visualize or even imagine. Consider trying to warn people in 1930 of a future nuclear arms race, when you couldn't show them a single nuclear explosion video and nobody even knew how to build such weapons. Even top scientists can underestimate uncertainty, making forecasts that are either too optimistic—Where are those fusion reactors and flying cars?—or too pessimistic. Ernest Rutherford, arguably the greatest nuclear physicist of his time, said in 1933—less than twenty-four hours before Leo Szilard conceived of the nuclear chain reaction—that nuclear energy was "moonshine." Essentially nobody at that time saw the nuclear arms race coming.

Third, psychologists have discovered that we tend to avoid thinking of disturbing threats when we believe there's nothing we can do about them anyway. In this case, however, there are many constructive things we can do, if we can get ourselves to start thinking about the issue.

What can we do?

I'm advocating a strategy change from *"Let's rush to build technology that makes us obsolete—what could possibly go wrong?"* to *"Let's envision an inspiring future and steer toward it."*

To motivate the effort required for steering, this strategy begins by envisioning an enticing destination. Although Hollywood's futures tend to be dystopian, the fact is that AGI can help life flourish as never before. Everything I love about civilization is the product of intelligence, so if we can amplify our own intelligence with AGI, we have the potential to solve today's and tomorrow's thorniest problems, including disease, climate change, and poverty. The more detailed we can make our shared positive visions for the future, the more motivated we will be to work together to realize them.

What should we do in terms of steering? The twenty-three Asilomar principles adopted in 2017 offer plenty of guidance, including these short-term goals:

(1) An arms race in lethal autonomous weapons should be avoided.

(2) The economic prosperity created by AI should be shared broadly, to benefit all of humanity.

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[17] Upton Sinclair, *I, Candidate for Governor: And How I Got Licked* (Berkeley CA: University of California Press, 1994), p. 109.

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(3) Investments in AI should be accompanied by funding for research on ensuring its beneficial use. . . . How can we make future AI systems highly robust, so that they do what we want without malfunctioning or getting hacked.[18]

The first two involve not getting stuck in suboptimal Nash equilibria. An out-of-control arms race in lethal autonomous weapons that drives the price of automated anonymous assassination toward zero will be very hard to stop once it gains momentum. The second goal would require reversing the current trend in some Western countries where sectors of the population are getting poorer in absolute terms, fueling anger, resentment, and polarization. Unless the third goal can be met, all the wonderful AI technology we create might harm us, either accidentally or deliberately.

AI safety research must be carried out with a strict deadline in mind: Before AGI arrives, we need to figure out how to make AI understand, adopt, and retain our goals. The more intelligent and powerful machines get, the more important it becomes to align their goals with ours. As long as we build relatively dumb machines, the question isn't whether human goals will prevail but merely how much trouble the machines can cause before we solve the goal-alignment problem. If a superintelligence is ever unleashed, however, it will be the other way around: Since intelligence is the ability to accomplish goals, a superintelligent AI is by definition much better at accomplishing its goals than we humans are at accomplishing ours, and will therefore prevail.

In other words, *the real risk with AGI isn't malice but competence*. A superintelligent AGI will be extremely good at accomplishing its goals, and if those goals aren't aligned with ours, we're in trouble. People don't think twice about flooding anthills to build hydroelectric dams, so let's not place humanity in the position of those ants. Most researchers argue that if we end up creating superintelligence, we should make sure it's what AI-safety pioneer Eliezer Yudkowsky has termed "friendly AI"—AI whose goals are in some deep sense beneficial.

The moral question of what these goals should be is just as urgent as the technical questions about goal alignment. For example, what sort of society are we hoping to create, where we find meaning and purpose in our lives even though we, strictly speaking, aren't needed? I'm often given the following glib response to this question: "*Let's build machines that are smarter than us and then let them figure out the answer!*" This mistakenly equates intelligence with morality. Intelligence isn't good or evil but morally neutral. It's simply an ability to accomplish complex goals, good or bad. We can't conclude that things would have been better if Hitler had been more intelligent. Indeed, postponing work on ethical issues until after goal-aligned AGI is built would be irresponsible and potentially disastrous. A perfectly obedient superintelligence whose goals automatically align with those of its human owner would be like Nazi SS-Obersturmbannführer Adolf Eichmann on steroids. Lacking moral compass or inhibitions of its own, it would, with ruthless efficiency, implement its owner's goals, whatever they might be.[19]

When I speak of the need to analyze technology risk, I'm sometimes accused of scaremongering. But here at MIT, where I work, we know that such risk analysis isn't scaremongering: It's *safety engineering*. Before the moon-landing mission, NASA

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[18] https://futureoflife.org/ai-principles/

[19] See, for example, Hannah Arendt, *Eichmann in Jerusalem: A Report on the Banality of Evil* (New York: Penguin Classics, 2006).

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systematically thought through everything that could possibly go wrong when putting astronauts on top of a 110-meter rocket full of highly flammable fuel and launching them to a place where nobody could help them—and there were lots of things that could go wrong. Was this scaremongering? No, this was the safety engineering that ensured the mission's success. Similarly, we should analyze what could go wrong with AI to ensure that it goes right.

Outlook

In summary, if our technology outpaces the wisdom with which we manage it, it can lead to our extinction. It's already caused the extinction of from 20 to 50 percent of all species on Earth, by some estimates,[20] and it would be ironic if we're next in line. It would also be pathetic, given that the opportunities offered by AGI are literally astronomical, potentially enabling life to flourish for billions of years not only on Earth but also throughout much of our cosmos.

Instead of squandering this opportunity through unscientific risk denial and poor planning, let's be ambitious! *Homo sapiens* is inspiringly ambitious, as reflected in William Ernest Henley's famous lines from *Invictus*: "I am the master of my fate, / I am the captain of my soul." Rather than drifting like a rudderless ship toward our own obsolescence, let's take on and overcome the technical and societal challenges standing between us and a good high-tech future. What about the existential challenges related to morality, goals, and meaning? There's no meaning encoded in the laws of physics, so instead of passively waiting for our Universe to give meaning to us, let's acknowledge and celebrate that it's we conscious beings who give meaning to our Universe. Let's create our own meaning, based on something more profound than having jobs. AGI can enable us to finally become the masters of our own destiny. Let's make that destiny a truly inspiring one!

[20] See Elizabeth Kolbert, *The Sixth Extinction: An Unnatural History* (New York: Henry Holt, 2014).

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Jaan Tallinn *grew up in Estonia, becoming one of its few computer game developers, when that nation was still a Soviet Socialist Republic. Here he compares the dissidents who brought down the Iron Curtain to the dissidents who are sounding the alarm about rapid advances in artificial intelligence. He locates the roots of the current AI dissidence, paradoxically, among such pioneers of the AI field as Wiener, Alan Turing, and I. J. Good.*

Jaan's preoccupation is with existential risk, AI being among the most extreme of many. In 2012, he co-founded the Centre for the Study of Existential Risk—an interdisciplinary research institute that works to mitigate risks "associated with emerging technologies and human activity"—at the University of Cambridge, along with philosopher Huw Price and Martin Rees, the Astronomer Royal.

He once described himself to me as "a convinced consequentialist"—convinced enough to have given away much of his entrepreneurial wealth to the Future of Life Institute (of which he is a co-founder), the Machine Intelligence Research Institute, and other such organizations working on risk reduction. Max Tegmark has written about him: "If you're an intelligent life-form reading this text millions of years from now and marveling at how life is flourishing, you may owe your existence to Jaan."

On a recent visit to London, Jaan and I participated on an AI panel for the Serpentine Gallery's Marathon at London's City Hall, under the aegis of Hans Ulrich Obrist (another contributor to this volume). This being the art world, there was a glamorous dinner party that night in a mansion filled with London's beautiful people—artists, fashion models, oligarchs, stars of stage and screen. After working the room in his unaffected manner ("Hi, I'm Jaan"), he suddenly said, "Time for hip-hop dancing," dropped to the floor on one hand, and began demonstrating his spectacular moves to the bemused A-listers. Then off he went into the dance-club subculture, which is apparently how he ends every evening when he's on the road. Who knew?

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DISSIDENT MESSAGES
Jaan Tallinn

***Jaan Tallin**, a computer programmer, theoretical physicist, and investor, is a co-developer of Skype and Kazaa.*

In March 2009, I found myself in a bland franchise eatery next to a noisy California freeway. I was there to meet a young man whose blog I had been following. To make himself recognizable, he wore a button with a text on it: *Speak the truth even if your voice trembles.* His name was Eliezer Yudkowsky, and we spent the next four hours discussing the message he had for the world—a message that had brought me to that eatery and would end up dominating my subsequent work.

The First Message: the Soviet Occupation

In *The Human Use of Human Beings*, Norbert Wiener looked at the world through the lens of communication. He saw a universe that was marching to the tune of the second law of thermodynamics toward its inevitable heat death. In such a universe, the only (meta)stable entities are *messages*—patterns of information that propagate through time, like waves propagating across the surface of a lake. Even we humans can be considered messages, because the atoms in our bodies are too fleeting to attach our identities to. Instead, we are the "message" that our bodily functions maintain. As Wiener put it: "It is the pattern maintained by this homeostasis, which is the touchstone of our personal identity."

I'm more used to treating processes and computation as the fundamental building blocks of the world. That said, Wiener's lens brings out some interesting aspects of the world which might otherwise have remained in the background and which to a large degree shaped my life. These are two messages, both of which have their roots in the Second World War. They started out as quiet dissident messages—messages that people didn't pay much attention to, even if they silently and perhaps subconsciously concurred. The first message was: *The Soviet Union is composed of a series of illegitimate occupations. These occupations must end.*

As an Estonian, I grew up behind the Iron Curtain and had a front row seat when it fell. I heard this first message in the nostalgic reminiscences of my grandparents and in between the harsh noises jamming the Voice of America. It grew louder during the Gorbachev era, as the state became more lenient in its treatment of dissidents, and reached a crescendo in the Estonian Singing Revolution of the late 1980s.

In my teens, I witnessed the message spread out across widening circles of people, starting with the active dissidents, who had voiced it for half a century at great cost to themselves, proceeding to the artists and literati, and ending up among the Party members and politicians who had switched sides. This new elite comprised an eclectic mix of people: those original dissidents who had managed to survive the repression, public intellectuals, and (to the great annoyance of the surviving dissidents) even former Communists. The remaining dogmatists—even the prominent ones—were eventually marginalized, some of them retreating to Russia.

Interestingly, as the message propagated from one group to the next, it evolved. It started in pure and uncompromising form ("The occupation must end!") among the dissidents who considered the truth more important than their personal freedom. The

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mainstream groups, who had more to lose, initially qualified and diluted the message, taking positions like, "It would make sense in the long term to delegate control over local matters." (There were always exceptions: Some public intellectuals proclaimed the original dissident message verbatim.) Finally, the original message—being, simply, true—won out over its diluted versions. Estonia regained its independence in 1991, and the last Soviet troops left three years later.

The people who took the risk and spoke the truth in Estonia and elsewhere in the Eastern Bloc played a monumental role in the eventual outcome—an outcome that changed the lives of hundreds of millions of people, myself included. They spoke the truth, even as their voices trembled.

The Second Message: AI Risk

My exposure to the second revolutionary message was via Yudkowsky's blog—the blog that compelled me to reach out and arrange that meeting in California. The message was: *Continued progress in AI can precipitate a change of cosmic proportions—a runaway process that will likely kill everyone. We need to put in a lot of extra effort to avoid that outcome*.

After my meeting with Yudkowsky, the first thing I did was try to interest my Skype colleagues and close collaborators in his warning. I failed. The message was too crazy, too dissident. Its time had not yet come.

Only later did I learn that Yudkowsky wasn't the original dissident speaking this particular truth. In April 2000, there was a lengthy opinion piece in *Wired* titled, "Why the Future Doesn't Need Us," by Bill Joy, co-founder and chief scientist of Sun Microsystems. He warned:

> Accustomed to living with almost routine scientific breakthroughs, we have yet to come to terms with the fact that the most compelling 21st-century technologies—robotics, genetic engineering, and nanotechnology—pose a different threat than the technologies that have come before. Specifically, robots, engineered organisms, and nanobots share a dangerous amplifying factor: They can self-replicate. . . . [O]ne bot can become many, and quickly get out of control.

Apparently, Joy's broadside caused a lot of furor but little action.

More surprising to me, though, was that the AI-risk message arose almost simultaneously with the field of computer science. In a 1951 lecture, Alan Turing announced: "[I]t seems probable that once the machine thinking method had started, it would not take long to outstrip our feeble powers. . . . At some stage, therefore, we should have to expect the machines to take control. . . ."[21] A decade or so later, his Bletchley Park colleague I. J. Good wrote, "The first ultraintelligent machine is the *last* invention that man need ever make, provided that the machine is docile enough to tell us how to keep it under control."[22] Indeed, I counted half a dozen places in *The Human Use of Human Beings* where Wiener hinted at one or another aspect of the Control Problem. ("The machine like the djinnee, which can learn and can make decisions on the basis of

[21] Posthumously reprinted in *Phil. Math.* (3) vol. 4, 256-60 (1966).

[22] Irving John Good, "Speculations concerning the first ultraintelligent machine," *Advances in Computers,* vol. 6 (Academic Press, 1965), pp. 31-88.

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its learning, will in no way be obliged to make such decisions as we should have made, or will be acceptable to us.") Apparently, the original dissidents promulgating the AI-risk message were the AI pioneers themselves!

Evolution's Fatal Mistake

There have been many arguments, some sophisticated and some less so, for why the Control Problem is real and not some science-fiction fantasy. Allow me to offer one that illustrates the magnitude of the problem:

For the last hundred thousand years, the world (meaning the Earth, but the argument extends to the solar system and possibly even to the entire universe) has been in the human-brain regime. In this regime, the brains of *Homo sapiens* have been the most sophisticated future-shaping mechanisms (indeed, some have called them the most complicated objects in the universe). Initially, we didn't use them for much beyond survival and tribal politics in a band of foragers, but now their effects are surpassing those of natural evolution. The planet has gone from producing forests to producing cities.

As predicted by Turing, once we have superhuman AI ("the machine thinking method"), the human-brain regime will end. Look around you—you're witnessing the final decades of a hundred-thousand-year regime. This thought alone should give people some pause before they dismiss AI as just another tool. One of the world's leading AI researchers recently confessed to me that he would be greatly relieved to learn that human-level AI was impossible for us to create.

Of course, it might still take us a long time to develop human-level AI. But we have reason to suspect that this is not the case. After all, it didn't take long, in relative terms, for evolution—the blind and clumsy optimization process—to create human-level intelligence once it had animals to work with. Or multicellular life, for that matter: Getting cells to stick together seems to have been much harder for evolution to accomplish than creating humans once there were multicellular organisms. Not to mention that our level of intelligence was limited by such grotesque factors as the width of the birth canal. Imagine an AI developer being stopped in his tracks because he couldn't manage to adjust the font size on his computer!

There's an interesting symmetry here: In fashioning humans, evolution created a system that is, at least in many important dimensions, a more powerful planner and optimizer than evolution itself is. We are the first species to understand that we're the product of evolution. Moreover, we've created many artifacts (radios, firearms, spaceships) that evolution would have little hope of creating. Our future, therefore, will be determined by our own decisions and no longer by biological evolution. In that sense, evolution has fallen victim to its own Control Problem.

We can only hope that we're smarter than evolution in that sense. We *are* smarter, of course, but will that be enough? We're about to find out.

The Present Situation

So here we are, more than half a century after the original warnings by Turing, Wiener, and Good, and a decade after people like me started paying attention to the AI-risk message. I'm glad to see that we've made a lot of progress in confronting this issue, but we're definitely not there yet. AI risk, although no longer a taboo topic, is not yet fully

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appreciated among AI researchers. AI risk is not yet common knowledge either. In relation to the timeline of the first dissident message, I'd say we're around the year 1988, when raising the Soviet-occupation topic was no longer a career-ending move but you still had to somewhat hedge your position. I hear similar hedging now—statements like, "I'm not concerned about superintelligent AI, but there are some real ethical issues in increased automation," or "It's good that some people are researching AI risk, but it's not a short-term concern," or even the very reasonable sounding, "These are small-probability scenarios, but their potentially high impact justifies the attention."

As far as message propagation goes, though, we are getting close to the tipping point. A recent survey of AI researchers who published at the two major international AI conferences in 2015 found that 40 percent now think that risks from highly advanced AI are either "an important problem" or "among the most important problems in the field."[23]

Of course, just as there were dogmatic Communists who never changed their position, it's all but guaranteed that some people will never admit that AI is potentially dangerous. Many of the deniers of the first kind came from the Soviet nomenklatura; similarly, the AI-risk deniers often have financial or other pragmatic motives. One of the leading motives is corporate profits. AI is profitable, and even in instances where it isn't, it's at least a trendy, forward-looking enterprise with which to associate your company. So a lot of the dismissive positions are products of corporate PR and legal machinery. In some very real sense, big corporations are nonhuman machines that pursue their own interests—interests that might not align with those of any particular human working for them. As Wiener observed in *The Human Use of Human Beings*: "When human atoms are knit into an organization in which they are used, not in their full right as responsible human beings, but as cogs and levers and rods, it matters little that their raw material is flesh and blood."

Another strong incentive to turn a blind eye to the AI risk is the (very human) curiosity that knows no bounds. "When you see something that is technically sweet, you go ahead and do it and you argue about what to do about it only after you have had your technical success. That is the way it was with the atomic bomb," said J. Robert Oppenheimer. His words were echoed recently by Geoffrey Hinton, arguably the inventor of deep learning, in the context of AI risk: "I could give you the usual arguments, but the truth is that the prospect of discovery is too sweet."

Undeniably, we have both entrepreneurial attitude and scientific curiosity to thank for almost all the nice things we take for granted in the modern era. It's important to realize, though, that progress does not *owe* us a good future. In Wiener's words, "It is possible to believe in progress as a fact without believing in progress as an ethical principle."

Ultimately, we don't have the luxury of waiting before all the corporate heads and AI researchers are willing to concede the AI risk. Imagine yourself sitting in a plane about to take off. Suddenly there's an announcement that 40 percent of the experts believe there's a bomb onboard. At that point, the course of action is already clear, and sitting there waiting for the remaining 60 percent to come around isn't part of it.

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[23] Katja Grace, et al., "When Will AI Exceed Human Performance? Evidence from AI Experts," https://arxiv.org/pdf/1705.08807.pdf.

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Calibrating the AI-Risk Message

While uncannily prescient, the AI-risk message from the original dissidents has a giant flaw—as does the version dominating current public discourse: Both considerably understate the magnitude of the problem as well as AI's potential upside. The message, in other words, does not adequately convey the stakes of the game.

Wiener primarily warned of the *social* risks—risks stemming from careless integration of machine-generated decisions with governance processes and misuse (by humans) of such automated decision making. Likewise, the current "serious" debate about AI risks focuses mostly on things like technological unemployment or biases in machine learning. While such discussions can be valuable and address pressing short-term problems, they are also stunningly parochial. I'm reminded of Yudkowsky's quip in a blog post: "[A]sking about the effect of *machine superintelligence* on the conventional human labor market is like asking how US–Chinese trade patterns would be affected by the Moon crashing into the Earth. There would indeed be effects, but you'd be missing the point."

In my view, the central point of the AI risk is that *superintelligent AI is an environmental risk*. Allow me to explain.

In his "Parable of the Sentient Puddle," Douglas Adams describes a puddle that wakes up in the morning and finds himself in a hole that fits him "staggeringly well." From that observation, the puddle concludes that the world must have been made for him. Therefore, writes Adams, "the moment he disappears catches him rather by surprise." To assume that AI risks are limited to adverse social developments is to make a similar mistake. The harsh reality is that the universe was not made for us; instead, we are fine-tuned by evolution to a very narrow range of environmental parameters. For instance, we need the atmosphere at ground level to be roughly at room temperature, at about 100 kPa pressure, and have a sufficient concentration of oxygen. Any disturbance, even temporary, of this precarious equilibrium and we die in a matter of minutes.

Silicon-based intelligence does not share such concerns about the environment. That's why it's much cheaper to explore space using machine probes rather than "cans of meat." Moreover, Earth's current environment is almost certainly suboptimal for what a superintelligent AI will greatly care about: *efficient computation*. Hence we might find our planet suddenly going from anthropogenic global warming to machinogenic global cooling. One big challenge that AI safety research needs to deal with is how to constrain a potentially superintelligent AI—an AI with a much larger footprint than our own—from rendering our environment uninhabitable for biological life-forms.

Interestingly, given that the most potent sources both of AI research and AI-risk dismissals are under big corporate umbrellas, if you squint hard enough the "AI as an environmental risk" message looks like the chronic concern about corporations skirting their environmental responsibilities.

Conversely, the worry about AI's social effects also misses most of the upside. It's hard to overemphasize how tiny and parochial the future of our planet is, compared with the full potential of humanity. On astronomical timescales, our planet will be gone soon (unless we tame the sun, also a distinct possibility) and almost all the resources—atoms and free energy—to sustain civilization in the long run are in deep space.

Eric Drexler, the inventor of nanotechnology, has recently been popularizing the

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concept of "Pareto-topia": the idea that AI, if done right, can bring about a future in which *everyone's* lives are hugely improved, a future where there are no losers. A key realization here is that what chiefly prevents humanity from achieving its full potential might be our instinctive sense that we're in a zero-sum game—a game in which players are supposed to eke out small wins at the expense of others. Such an instinct is seriously misguided and destructive in a "game" where everything is at stake and the payoff is literally astronomical. There are many more star systems in our galaxy alone than there are people on Earth.

Hope

As of this writing, I'm cautiously optimistic that the AI-risk message can save humanity from extinction, just as the Soviet-occupation message ended up liberating hundreds of millions of people. As of 2015, it had reached and converted 40 percent of AI researchers. It wouldn't surprise me if a new survey now would show that the majority of AI researchers believe AI safety to be an important issue.

I'm delighted to see the first technical AI-safety papers coming out of DeepMind, OpenAI, and Google Brain and the collaborative problem-solving spirit flourishing between the AI-safety research teams in these otherwise very competitive organizations.

The world's political and business elite are also slowly waking up: AI safety has been covered in reports and presentations by the Institute of Electrical and Electronics Engineers (IEEE), the World Economic Forum, and the Organization for Economic Cooperation and Development (OECD). Even the recent (July 2017) Chinese AI manifesto contained dedicated sections on "AI safety supervision" and "Develop[ing] laws, regulations, and ethical norms" and establishing "an AI security and evaluation system" to, among other things, "[e]nhance the awareness of risk." I very much hope that a new generation of leaders who understand the AI Control Problem and AI as the ultimate environmental risk can rise above the usual tribal, zero-sum games and steer humanity past these dangerous waters we are in—thereby opening our way to the stars that have been waiting for us for billions of years.

Here's to our next hundred thousand years! And don't hesitate to speak the truth, even if your voice trembles.

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Throughout his career, whether studying language, advocating a realistic biology of mind, or examining the human condition through the lens of humanistic Enlightenment ideas, psychologist **Steven Pinker** *has embraced and championed a naturalistic understanding of the universe and the computational theory of mind. He is perhaps the first internationally recognized public intellectual whose recognition is based on the advocacy of empirically based thinking about language, mind, and human nature.*

"Just as Darwin made it possible for a thoughtful observer of the natural world to do without creationism," he says, "Turing and others made it possible for a thoughtful observer of the cognitive world to do without spiritualism."

In the debate about AI risk, he argues against prophecies of doom and gloom, noting that they spring from the worst of our psychological biases—exemplified particularly by media reports: "Disaster scenarios are cheap to play out in the probability-free zone of our imaginations, and they can always find a worried, technophobic, or morbidly fascinated audience." Hence, over the centuries: Pandora, Faust, the Sorcerer's Apprentice, Frankenstein, the population bomb, resource depletion, HAL, suitcase nukes, the Y2K bug, and engulfment by nanotechnological grey goo. "A characteristic of AI dystopias," he points out, "is that they project a parochial alpha-male psychology onto the concept of intelligence. . . . History does turn up the occasional megalomaniacal despot or psychopathic serial killer, but these are products of a history of natural selection shaping testosterone-sensitive circuits in a certain species of primate, not an inevitable feature of intelligent systems."

In the present essay, he applauds Wiener's belief in the strength of ideas vis-à-vis the encroachment of technology. As Wiener so aptly put it, "The machine's danger to society is not from the machine itself but from what man makes of it."

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TECH PROPHECY AND THE UNDERAPPRECIATED CAUSAL POWER OF IDEAS

Steven Pinker

Steven Pinker, *a Johnstone Family Professor in the Department of Psychology at Harvard University, is an experimental psychologist who conducts research in visual cognition, psycholinguistics, and social relations. He is the author of eleven books, including* The Blank Slate, The Better Angels of Our Nature, *and, most recently,* Enlightenment Now: The Case for Reason, Science, Humanism, and Progress.

Artificial intelligence is an existence proof of one of the great ideas in human history: that the abstract realm of knowledge, reason, and purpose does not consist of an élan vital or immaterial soul or miraculous powers of neural tissue. Rather, it can be linked to the physical realm of animals and machines via the concepts of information, computation, and control. Knowledge can be explained as patterns in matter or energy that stand in systematic relations with states of the world, with mathematical and logical truths, and with one another. Reasoning can be explained as transformations of that knowledge by physical operations that are designed to preserve those relations. Purpose can be explained as the control of operations to effect changes in the world, guided by discrepancies between its current state and a goal state. Naturally evolved brains are just the most familiar systems that achieve intelligence through information, computation, and control. Humanly designed systems that achieve intelligence vindicate the notion that information processing is sufficient to explain it—the notion that the late Jerry Fodor dubbed the computational theory of mind.

The touchstone for this volume, Norbert Wiener's *The Human Use of Human Beings,* celebrated this intellectual accomplishment, of which Wiener himself was a foundational contributor. A potted history of the mid-20th-century revolution that gave the world the computational theory of mind might credit Claude Shannon and Warren Weaver for explaining knowledge and communication in terms of information. It might credit Alan Turing and John von Neumann for explaining intelligence and reasoning in terms of computation. And it ought to give Wiener credit for explaining the hitherto mysterious world of purposes, goals, and teleology in terms of the technical concepts of feedback, control, and cybernetics (in its original sense of "governing" the operation of a goal-directed system). "It is my thesis," he announced, "that the physical functioning of the living individual and the operation of some of the newer communication machines are precisely parallel in their analogous attempts to control entropy through feedback"—the staving off of life-sapping entropy being the ultimate goal of human beings.

Wiener applied the ideas of cybernetics to a third system: society. The laws, norms, customs, media, forums, and institutions of a complex community could be considered channels of information propagation and feedback that allow a society to ward off disorder and pursue certain goals. This is a thread that runs through the book and which Wiener himself may have seen as its principal contribution. In his explanation of feedback, he wrote, "This complex of behavior is ignored by the average man, and in particular does not play the role that it should in our habitual analysis of society; for just as individual physical responses may be seen from this point of view, so may the organic responses of society itself."

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Indeed, Wiener gave scientific teeth to the idea that in the workings of history, politics, and society, *ideas matter*. Beliefs, ideologies, norms, laws, and customs, by regulating the behavior of the humans who share them, can shape a society and power the course of historical events as surely as the phenomena of physics affect the structure and evolution of the solar system. To say that ideas—and not just weather, resources, geography, or weaponry—can shape history is not woolly mysticism. It is a statement of the causal powers of information instantiated in human brains and exchanged in networks of communication and feedback. Deterministic theories of history, whether they identify the causal engine as technological, climatological, or geographic, are belied by the causal power of ideas. The effects of these ideas can include unpredictable lurches and oscillations that arise from positive feedback or from miscalibrated negative feedback.

An analysis of society in terms of its propagation of ideas also gave Wiener a guideline for social criticism. A healthy society—one that gives its members the means to pursue life in defiance of entropy—allows information sensed and contributed by its members to feed back and affect how the society is governed. A dysfunctional society invokes dogma and authority to impose control from the top down. Wiener thus described himself as "a participant in a liberal outlook," and devoted most of the moral and rhetorical energy in the book (both the 1950 and 1954 editions) to denouncing communism, fascism, McCarthyism, militarism, and authoritarian religion (particularly Catholicism and Islam) and to warning that political and scientific institutions were becoming too hierarchical and insular.

Wiener's book is also, here and there, an early exemplar of an increasingly popular genre, tech prophecy. Prophecy not in the sense of mere prognostications but in the Old Testament sense of dark warnings of catastrophic payback for the decadence of one's contemporaries. Wiener warned against the accelerating nuclear arms race, against technological change that was imposed without regard to human welfare ("[W]e must know as scientists what man's nature is and what his built-in purposes are"), and against what today is called the value-alignment problem: that "the machine like the djinnee, which can learn and can make decisions on the basis of its learning, will in no way be obliged to make such decisions as we should have made, or will be acceptable to us." In the darker, 1950 edition, he warned of a "threatening new Fascism dependent on the *machine à gouverner*."

Wiener's tech prophecy harks back to the Romantic movement's rebellion against the "dark Satanic mills" of the Industrial Revolution, and perhaps even earlier, to the archetypes of Prometheus, Pandora, and Faust. And today it has gone into high gear. Jeremiahs, many of them (like Wiener) from the worlds of science and technology, have sounded alarms about nanotechnology, genetic engineering, Big Data, and particularly artificial intelligence. Several contributors to this volume characterize Wiener's book as a prescient example of tech prophecy and amplify his dire worries.

Yet the two moral themes of *The Human Use of Human Beings*—the liberal defense of an open society and the dystopian dread of runaway technology—are in tension. A society with channels of feedback that maximize human flourishing will have mechanisms in place, and can adapt them to changing circumstances, in a way that can domesticate technology to human purposes. There's nothing idealistic or mystical about this; as Wiener emphasized, ideas, norms, and institutions are themselves a form of technology, consisting of patterns of information distributed across brains. The

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possibility that machines threaten a new fascism must be weighed against the vigor of the liberal ideas, institutions, and norms that Wiener championed throughout the book. The flaw in today's dystopian prophecies is that they disregard the existence of these norms and institutions, or drastically underestimate their causal potency. The result is a technological determinism whose dark predictions are repeatedly refuted by the course of events. The numbers "1984" and "2001" are good reminders.

I will consider two examples. Tech prophets often warn of a "surveillance state" in which a government empowered by technology will monitor and interpret all private communications, allowing it to detect dissent and subversion as it arises and make resistance to state power futile. Orwell's telescreens are the prototype, and in 1976 Joseph Weizenbaum, one of the gloomiest tech prophets of all time, warned my class of graduate students not to pursue automatic speech recognition because government surveillance was its only conceivable application.

Though I am on record as an outspoken civil libertarian, deeply concerned with contemporary threats to free speech, I lose no sleep over technological advances in the Internet, video, or artificial intelligence. The reason is that almost all the variation across time and space in freedom of thought is driven by differences in norms and institutions and almost none of it by differences in technology. Though one can imagine hypothetical combinations of the most malevolent totalitarians with the most advanced technology, in the real world it's the norms and laws we should be vigilant about, not the tech.

Consider variation across time. If, as Orwell hinted, advancing technology was a prime enabler of political repression, then Western societies should have gotten more and more restrictive of speech over the centuries, with a dramatic worsening in the second half of the 20th century continuing into the 21st. That's not how history unfolded. It was the centuries when communication was implemented by quills and inkwells that had autos-da-fé and the jailing or guillotining of Enlightenment thinkers. During World War I, when the state of the art was the wireless, Bertrand Russell was jailed for his pacifist opinions. In the 1950s, when computers were room-size accounting machines, hundreds of liberal writers and scholars were professionally punished. Yet in the technologically accelerating, hyperconnected 21st century, 18 percent of social science professors are Marxists[24]; the President of the United States is nightly ridiculed by television comedians as a racist, pervert, and moron; and technology's biggest threat to political discourse comes from amplifying too many dubious voices rather than suppressing enlightened ones.

Now consider variations across place. Western countries at the technological frontier consistently get the highest scores in indexes of democracy and human rights, while many backward strongman states are at the bottom, routinely jailing or killing government critics. The lack of a correlation between technology and repression is unsurprising when you analyze the channels of information flow in any human society. For dissidents to be influential, they have to get their message out to a wide network via whatever channels of communication are available—pamphleteering, soap-box oration, subversive soirées in cafés and pubs, word of mouth. These channels enmesh influential dissidents in a broad social network which makes them easy to identify and track down.

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[24] Neil Gross & Solon Simmons, "The Social and Political Views of American College and University Professors," in N. Gross & S. Simmons, eds., *Professors and Their Politics* (Baltimore: Johns Hopkins University Press, 2014).

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All the more so when dictators rediscover the time-honored technique of weaponizing the people against each other by punishing those who don't denounce or punish others.

In contrast, technologically advanced societies have long had the means to install Internet-connected, government-monitored surveillance cameras in every bar and bedroom. Yet that has not happened, because democratic governments (even the current American administration, with its flagrantly antidemocratic impulses) lack the will and the means to enforce such surveillance on an obstreperous people accustomed to saying what they want. Occasionally, warnings of nuclear, biological, or cyberterrorism goad government security agencies into measures such as hoovering up mobile phone metadata, but these ineffectual measures, more theater than oppression, have had no significant effect on either security or freedom. Ironically, tech prophecy plays a role in encouraging these measures. By sowing panic about supposed existential threats such as suitcase nuclear bombs and bioweapons assembled in teenagers' bedrooms, they put pressure on governments to prove they're doing something, anything, to protect the American people.

It's not that political freedom takes care of itself. It's that the biggest threats lie in the networks of ideas, norms, and institutions that allow information to feed back (or not) on collective decisions and understanding. As opposed to the chimerical technological threats, one real threat today is oppressive political correctness, which has choked the range of publicly expressible hypotheses, terrified many intelligent people against entering the intellectual arena, and triggered a reactionary backlash. Another real threat is the combination of prosecutorial discretion with an expansive lawbook filled with vague statutes. The result is that every American unwittingly commits "three felonies a day" (as the title of a book by civil libertarian Harvey Silverglate puts it) and is in jeopardy of imprisonment whenever it suits the government's needs. It's this prosecutorial weaponry that makes Big Brother all-powerful, not telescreens. The activism and polemicizing directed against government surveillance programs would be better directed at its overweening legal powers.

The other focus of much tech prophecy today is artificial intelligence, whether in the original sci-fi dystopia of computers running amok and enslaving us in an unstoppable quest for domination, or the newer version in which they subjugate us by accident, single-mindedly seeking some goal we give them regardless of its side effects on human welfare (the value-alignment problem adumbrated by Wiener). Here again both threats strike me as chimerical, growing from a narrow technological determinism that neglects the networks of information and control in an intelligent system like a computer or brain and in a society as a whole.

The subjugation fear is based on a muzzy conception of intelligence that owes more to the Great Chain of Being and a Nietzschean will to power than to a Wienerian analysis of intelligence and purpose in terms of information, computation, and control. In these horror scenarios, intelligence is portrayed as an all-powerful, wish-granting potion that agents possess in different amounts. Humans have more of it than animals, and an artificially intelligent computer or robot will have more of it than humans. Since we humans have used our moderate endowment to domesticate or exterminate less well-endowed animals (and since technologically advanced societies have enslaved or annihilated technologically primitive ones), it follows that a supersmart AI would do the same to us. Since an AI will think millions of times faster than we do, and use its

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superintelligence to recursively improve its superintelligence, from the instant it is turned on we will be powerless to stop it.

But these scenarios are based on a confusion of intelligence with motivation—of beliefs with desires, inferences with goals, the computation elucidated by Turing and the control elucidated by Wiener. Even if we did invent superhumanly intelligent robots, why would they *want* to enslave their masters or take over the world? Intelligence is the ability to deploy novel means to attain a goal. But the goals are extraneous to the intelligence: Being smart is not the same as wanting something. It just so happens that the intelligence in *Homo sapiens* is a product of Darwinian natural selection, an inherently competitive process. In the brains of that species, reasoning comes bundled with goals such as dominating rivals and amassing resources. But it's a mistake to confuse a circuit in the limbic brain of a certain species of primate with the very nature of intelligence. There is no law of complex systems that says that intelligent agents must turn into ruthless megalomaniacs.

A second misconception is to think of intelligence as a boundless continuum of potency, a miraculous elixir with the power to solve any problem, attain any goal. The fallacy leads to nonsensical questions like when an AI will "exceed human-level intelligence," and to the image of an "artificial general intelligence" (AGI) with God-like omniscience and omnipotence. Intelligence is a contraption of gadgets: software modules that acquire, or are programmed with, knowledge of how to pursue various goals in various domains. People are equipped to find food, win friends and influence people, charm prospective mates, bring up children, move around in the world, and pursue other human obsessions and pastimes. Computers may be programmed to take on some of these problems (like recognizing faces), not to bother with others (like charming mates), and to take on still other problems that humans can't solve (like simulating the climate or sorting millions of accounting records). The problems are different, and the kinds of knowledge needed to solve them are different.

But instead of acknowledging the centrality of knowledge to intelligence, the dystopian scenarios confuse an artificial general intelligence of the future with Laplace's demon, the mythical being that knows the location and momentum of every particle in the universe and feeds them into equations for physical laws to calculate the state of everything at any time in the future. For many reasons, Laplace's demon will never be implemented in silicon. A real-life intelligent system has to acquire information about the messy world of objects and people by engaging with it one domain at a time, the cycle being governed by the pace at which events unfold in the physical world. That's one of the reasons that understanding does not obey Moore's Law: Knowledge is acquired by formulating explanations and testing them against reality, not by running an algorithm faster and faster. Devouring the information on the Internet will not confer omniscience either: Big Data is still finite data, and the universe of knowledge is infinite.

A third reason to be skeptical of a sudden AI takeover is that it takes too seriously the inflationary phase in the AI hype cycle in which we are living today. Despite the progress in machine learning, particularly multilayered artificial neural networks, current AI systems are nowhere near achieving general intelligence (if that concept is even coherent). Instead, they are restricted to problems that consist of mapping well-defined inputs to well-defined outputs in domains where gargantuan training sets are available, in which the metric for success is immediate and precise, in which the environment doesn't

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change, and in which no stepwise, hierarchical, or abstract reasoning is necessary. Many of the successes come not from a better understanding of the workings of intelligence but from the brute-force power of faster chips and Bigger Data, which allow the programs to be trained on millions of examples and generalize to similar new ones. Each system is an idiot savant, with little ability to leap to problems it was not set up to solve, and a brittle mastery of those it was. And to state the obvious, none of these programs has made a move toward taking over the lab or enslaving its programmers.

Even if an artificial intelligence system tried to exercise a will to power, without the cooperation of humans it would remain an impotent brain in a vat. A superintelligent system, in its drive for self-improvement, would somehow have to build the faster processors that it would run on, the infrastructure that feeds it, and the robotic effectors that connect it to the world—all impossible unless its human victims worked to give it control of vast portions of the engineered world. Of course, one can always imagine a Doomsday Computer that is malevolent, universally empowered, always on, and tamperproof. The way to deal with this threat is straightforward: Don't build one.

What about the newer AI threat, the value-alignment problem, foreshadowed in Wiener's allusions to stories of the Monkey's Paw, the genie, and King Midas, in which a wisher rues the unforeseen side effects of his wish? The fear is that we might give an AI system a goal and then helplessly stand by as it relentlessly and literal-mindedly implemented its interpretation of that goal, the rest of our interests be damned. If we gave an AI the goal of maintaining the water level behind a dam, it might flood a town, not caring about the people who drowned. If we gave it the goal of making paper clips, it might turn all the matter in the reachable universe into paper clips, including our possessions and bodies. If we asked it to maximize human happiness, it might implant us all with intravenous dopamine drips, or rewire our brains so we were happiest sitting in jars, or, if it had been trained on the concept of happiness with pictures of smiling faces, tile the galaxy with trillions of nanoscopic pictures of smiley-faces.

Fortunately, these scenarios are self-refuting. They depend on the premises that (1) humans are so gifted that they can design an omniscient and omnipotent AI, yet so idiotic that they would give it control of the universe without testing how it works; and (2) the AI would be so brilliant that it could figure out how to transmute elements and rewire brains, yet so imbecilic that it would wreak havoc based on elementary blunders of misunderstanding. The ability to choose an action that best satisfies conflicting goals is not an add-on to intelligence that engineers might forget to install and test; it *is* intelligence. So is the ability to interpret the intentions of a language user in context.

When we put aside fantasies like digital megalomania, instant omniscience, and perfect knowledge and control of every particle in the universe, artificial intelligence is like any other technology. It is developed incrementally, designed to satisfy multiple conditions, tested before it is implemented, and constantly tweaked for efficacy and safety.

The last criterion is particularly significant. The culture of safety in advanced societies is an example of the humanizing norms and feedback channels that Wiener invoked as a potent causal force and advocated as a bulwark against the authoritarian or exploitative implementation of technology. Whereas at the turn of the 20th century Western societies tolerated shocking rates of mutilation and death in industrial, domestic, and transportation accidents, over the course of the century the value of human life

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increased. As a result, governments and engineers used feedback from accident statistics to implement countless regulations, devices, and design changes that made technology progressively safer. The fact that some regulations (such as using a cell phone near a gas pump) are ludicrously risk-averse underscores the point that we have become a society obsessed with safety, with fantastic benefits as a result: Rates of industrial, domestic, and transportation fatalities have fallen by more than 95 (and often 99) percent since their highs in the first half of the 20th century.[25] Yet tech prophets of malevolent or oblivious artificial intelligence write as if this momentous transformation never happened and one morning engineers will hand total control of the physical world to untested machines, heedless of the human consequences.

Norbert Wiener explained ideas, norms, and institutions in terms of computational and cybernetic processes that were scientifically intelligible and causally potent. He explained human beauty and value as "a local and temporary fight against the Niagara of increasing entropy" and expressed the hope that an open society, guided by feedback on human well-being, would enhance that value. Fortunately his belief in the causal power of ideas counteracted his worries about the looming threat of technology. As he put it, "the machine's danger to society is not from the machine itself but from what man makes of it." It is only by remembering the causal power of ideas that we can accurately assess the threats and opportunities presented by artificial intelligence today.

[25] Steven Pinker, "Safety," *Enlightenment Now: The Case for Reason, Science, Humanism, and Progress* (New York: Penguin, 2018).

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The most significant developments in the sciences today (i.e., those that affect the lives of everybody on the planet) are about, informed by, or implemented through advances in software and computation. Central to the future of these developments is physicist **David Deutsch,** *the founder of the field of quantum computation, whose 1985 paper on universal quantum computers was the first full treatment of the subject; the Deutsch-Jozsa algorithm was the first quantum algorithm to demonstrate the enormous potential power of quantum computation.*

When he initially proposed it, quantum computation seemed practically impossible. But the explosion in the construction of simple quantum computers and quantum communication systems never would have taken place without his work. He has made many other important contributions in areas such as quantum cryptography and the many-worlds interpretation of quantum theory. In a philosophic paper (with Artur Ekert), he appealed to the existence of a distinctive quantum theory of computation to argue that our knowledge of mathematics is derived from, and subordinate to, our knowledge of physics (even though mathematical truth is independent of physics).

Because he has spent a good part of his working life changing people's worldviews, his recognition among his peers as an intellectual goes well beyond his scientific achievement. He argues (following Karl Popper) that scientific theories are "bold conjectures," not derived from evidence but only tested by it. His two main lines of research at the moment—qubit-field theory and constructor theory—may well yield important extensions of the computational idea.

In the following essay, he more or less aligns himself with those who see human-level artificial intelligence as promising us a better world rather than the Apocalypse. In fact, he pleads for AGI to be, in effect, given its head, free to conjecture—a proposition that several other contributors to this book would consider dangerous.

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BEYOND REWARD AND PUNISHMENT
David Deutsch

David Deutsch *is a quantum physicist and a member of the Centre for Quantum Computation at the Clarendon Laboratory, Oxford University. He is the author of* The Fabric of Reality *and* The Beginning of Infinity.

First Murderer:
We are men, my liege.
Macbeth:
Ay, in the catalogue ye go for men,
As hounds and greyhounds, mongrels, spaniels, curs,
Shoughs, water-rugs, and demi-wolves are clept
All by the name of dogs.

William Shakespeare – *Macbeth*

For most of our species' history, our ancestors were barely people. This was not due to any inadequacy in their brains. On the contrary, even before the emergence of our anatomically modern human sub-species, they were making things like clothes and campfires, using knowledge that was not in their genes. It was created in their brains by thinking, and preserved by individuals in each generation imitating their elders. Moreover, this must have been knowledge in the sense of *understanding*, because it is impossible to imitate novel complex behaviors like those without understanding what the component behaviors are for.[26]

Such knowledgeable imitation depends on successfully guessing explanations, whether verbal or not, of what the other person is trying to achieve and how each of his actions contributes to that—for instance, when he cuts a groove in some wood, gathers dry kindling to put in it, and so on.

The complex cultural knowledge that this form of imitation permitted must have been extraordinarily useful. It drove rapid evolution of anatomical changes, such as increased memory capacity and more gracile (less robust) skeletons, appropriate to an ever more technology-dependent lifestyle. No nonhuman ape today has this ability to imitate novel complex behaviors. Nor does any present-day artificial intelligence. But our pre-*sapiens* ancestors did.

Any ability based on guessing must include means of correcting one's guesses, since most guesses will be wrong at first. (There are always many more ways of being wrong than right.) Bayesian updating is inadequate, because it cannot generate novel guesses about the purpose of an action, only fine-tune—or, at best, choose among—existing ones. Creativity is needed. As the philosopher Karl Popper explained, creative criticism, interleaved with creative conjecture, is how humans learn one another's behaviors, including language, and extract meaning from one another's utterances.[27]

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[26] "Aping" (imitating certain behaviors without understanding) uses inborn hacks such as the mirror-neuron system. But behaviors imitated that way are drastically limited in complexity. See Richard Byrne, "Imitation as Behaviour Parsing," *Phil. Trans. R. Soc.,* B 358:1431, 529-36 (2003).
[27] Karl Popper, *Conjectures and Refutations* (1963).

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Those are also the processes by which all new knowledge is created: They are how we innovate, make progress, and create abstract understanding for its own sake. This is human-level intelligence: thinking. It is also, or should be, the property we seek in artificial general intelligence (AGI). Here I'll reserve the term "thinking" for processes that can create understanding (explanatory knowledge). Popper's argument implies that all thinking entities—human or not, biological or artificial—must create such knowledge in fundamentally the same way. Hence understanding any of those entities requires traditionally human concepts such as culture, creativity, disobedience, and morality—which justifies using the uniform term *people* to refer to all of them.

Misconceptions about human thinking and human origins are causing corresponding misconceptions about AGI and how it might be created. For example, it is generally assumed that the evolutionary pressure that produced modern humans was provided by the benefits of having an ever greater ability to innovate. But if that were so, there would have been rapid progress as soon as thinkers existed, just as we hope will happen when we create artificial ones. If thinking had been commonly used for anything other than imitating, it would also have been used for innovation, even if only by accident, and innovation would have created opportunities for further innovation, and so on exponentially. But instead, there were hundreds of thousands of years of near stasis. Progress happened only on timescales much longer than people's lifetimes, so in a typical generation no one benefited from any progress. Therefore, the benefits of the ability to innovate can have exerted little or no evolutionary pressure during the biological evolution of the human brain. That evolution was driven by the benefits of *preserving* cultural knowledge.

Benefits to the genes, that is. Culture, in that era, was a very mixed blessing to individual people. Their cultural knowledge was indeed good enough to enable them to outclass all other large organisms (they rapidly became the top predator, etc.), even though it was still extremely crude and full of dangerous errors. But culture consists of transmissible information—memes—and meme evolution, like gene evolution, tends to favor high-fidelity transmission. And high-fidelity meme transmission necessarily entails the suppression of attempted progress. So it would be a mistake to imagine an idyllic society of hunter-gatherers, learning at the feet of their elders to recite the tribal lore by heart, being content despite their lives of suffering and grueling labor and despite expecting to die young and in agony of some nightmarish disease or parasite. Because, even if they could conceive of nothing better than such a life, those torments were the least of their troubles. For suppressing innovation in human minds (without killing them) is a trick that can be achieved only by human action, and it is an ugly business.

This has to be seen in perspective. In the civilization of the West today, we are shocked by the depravity of, for instance, parents who torture and murder their children for not faithfully enacting cultural norms. And even more by societies and subcultures where that is commonplace and considered honorable. And by dictatorships and totalitarian states that persecute and murder entire harmless populations for behaving differently. We are ashamed of our own recent past, in which it was honorable to beat children bloody for mere disobedience. And before that, to own human beings as slaves. And before that, to burn people to death for being infidels, to the applause and amusement of the public. Steven Pinker's book *The Better Angels of our Nature* contains accounts of horrendous evils that were normal in historical civilizations. Yet even they

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did not extinguish innovation as efficiently as it was extinguished among our forebears in prehistory for thousands of centuries.[28]

That is why I say that prehistoric people, at least, were barely people. Both before and after becoming perfectly human both physiologically and in their mental potential, they were monstrously inhuman in the actual content of their thoughts. I'm not referring to their crimes or even their cruelty as such: Those are all too human. Nor could mere cruelty have reduced progress that effectively. Things like "the thumbscrew and the stake / For the glory of the Lord"[29] were for reining in the few deviants who had somehow escaped mental standardization, which would normally have taken effect long before they were in danger of inventing heresies. From the earliest days of thinking onward, children must have been cornucopias of creative ideas and paragons of critical thought—otherwise, as I said, they could not have learned language or other complex culture. Yet, as Jacob Bronowski stressed in *The Ascent of Man*:

> For most of history, civilisations have crudely ignored that enormous potential. . . . [C]hildren have been asked simply to conform to the image of the adult. . . . The girls are little mothers in the making. The boys are little herdsmen. They even carry themselves like their parents.

But of course, they weren't just "asked" to ignore their enormous potential and conform faithfully to the image fixed by tradition: They were somehow trained to be psychologically unable to deviate from it. By now, it is hard for us even to conceive of the kind of relentless, finely tuned oppression required to reliably extinguish, in everyone, the aspiration to progress and replace it with dread and revulsion at any novel behavior. In such a culture, there can have been no morality other than conformity and obedience, no other identity than one's status in a hierarchy, no mechanisms of cooperation other than punishment and reward. So everyone had the same aspiration in life: to avoid the punishments and get the rewards. In a typical generation, no one invented anything, because no one aspired to anything new, because everyone had already despaired of improvement being possible. Not only was there no technological innovation or theoretical discovery, there were no new worldviews, styles of art, or interests that could have inspired those. By the time individuals grew up, they had in effect been reduced to AIs, programmed with the exquisite skills needed to enact that static culture and to inflict on the next generation their inability even to consider doing otherwise.

A present-day AI is not a mentally disabled AGI, so it would not be harmed by having its mental processes directed still more narrowly to meeting some predetermined criterion. "Oppressing" Siri with humiliating tasks may be weird, but it is not immoral nor does it harm Siri. On the contrary, all the effort that has ever increased the capabilities of AIs has gone into narrowing their range of potential "thoughts." For example, take chess engines. Their basic task has not changed from the outset: Any chess position has a finite tree of possible continuations; the task is to find one that leads to a predefined goal (a checkmate, or failing that, a draw). But the tree is far too big to

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[28] Matt Ridley, in *The Rational Optimist,* rightly stresses the positive effect of population on the rate of progress. But that has never yet been the biggest factor: Consider, say, ancient Athens versus the rest of the world at the time.

[29] Alfred, Lord Tennyson, *The Revenge* (1878).

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search exhaustively. Every improvement in chess-playing AIs, between Alan Turing's first design for one in 1948 and today's, has been brought about by ingeniously confining the program's attention (or making it confine its attention) ever more narrowly to branches likely to lead to that immutable goal. Then those branches are evaluated according to that goal.

That is a good approach to developing an AI with a fixed goal under fixed constraints. But if an AGI worked like that, the evaluation of each branch would have to constitute a prospective reward or threatened punishment. And that is diametrically the wrong approach if we're seeking a *better* goal under *unknown* constraints—which is the capability of an AGI. An AGI is certainly capable of learning to win at chess—but also of choosing not to. Or deciding in mid-game to go for the most interesting continuation instead of a winning one. Or inventing a new game. A mere AI is incapable of having any such ideas, because the capacity for considering them has been designed out of its constitution. That disability is the very means by which it plays chess.

An AGI is capable of enjoying chess, and of improving at it *because* it enjoys playing. Or of trying to win by causing an amusing configuration of pieces, as grand masters occasionally do. Or of adapting notions from its other interests to chess. In other words, it learns and plays chess by thinking some of the very thoughts that are forbidden to chess-playing AIs.

An AGI is also capable of refusing to display any such capability. And then, if threatened with punishment, of complying, or rebelling. Daniel Dennett, in his essay for this volume, suggests that punishing an AGI is impossible:

> [L]ike Superman, they are too invulnerable to be able to make a credible promise. . . . What would be the penalty for promise- breaking? Being locked in a cell or, more plausibly, dismantled?. . . The very ease of digital recording and transmitting—the breakthrough that permits software and data to be, in effect, immortal—removes robots from the world of the vulnerable. . . .

But this is not so. Digital immortality (which is on the horizon for humans, too, perhaps sooner than AGI) does not confer this sort of invulnerability. Making a (running) copy of oneself entails sharing one's possessions with it somehow—including the hardware on which the copy runs—so making such a copy is very costly for the AGI. Similarly, courts could, for instance, impose fines on a criminal AGI which would diminish its access to physical resources, much as they do for humans. Making a backup copy to evade the consequences of one's crimes is similar to what a gangster boss does when he sends minions to commit crimes and take the fall if caught: Society has developed legal mechanisms for coping with this.

But anyway, the idea that it is primarily for fear of punishment that we obey the law and keep promises effectively denies that we are moral agents. Our society could not work if that were so. No doubt there will be AGI criminals and enemies of civilization, just as there are human ones. But there is no reason to suppose that an AGI created in a society consisting primarily of decent citizens, and raised without what William Blake called "mind-forg'd manacles," will in general impose such manacles on itself (i.e., become irrational) and/or choose to be an enemy of civilization.

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The moral component, the cultural component, the element of free will—all make the task of creating an AGI fundamentally different from any other programming task. It's much more akin to raising a child. Unlike all present-day computer programs, an AGI has no specifiable functionality—no fixed, testable criterion for what shall be a successful output for a given input. Having its decisions dominated by a stream of externally imposed rewards and punishments would be poison to such a program, as it is to creative thought in humans. Setting out to create a chess-playing AI is a wonderful thing; setting out to create an AGI that cannot help playing chess would be as immoral as raising a child to lack the mental capacity to choose his own path in life.

Such a person, like any slave or brainwashing victim, would be morally entitled to rebel. And sooner or later, some of them would, just as human slaves do. AGIs could be very dangerous—exactly as humans are. But people—human or AGI—who are members of an open society do not have an inherent tendency to violence. The feared robot apocalypse will be avoided by ensuring that all people have full "human" rights, as well as the same cultural membership as humans. Humans living in an open society—the only stable kind of society—choose their own rewards, internal as well as external. Their decisions are not, in the normal course of events, determined by a fear of punishment.

Current worries about rogue AGIs mirror those that have always existed about rebellious youths—namely, that they might grow up deviating from the culture's moral values. But today the source of all existential dangers from the growth of knowledge is not rebellious youths but weapons in the hands of the enemies of civilization, whether these weapons are mentally warped (or enslaved) AGIs, mentally warped teenagers, or any other weapon of mass destruction. Fortunately for civilization, the more a person's creativity is forced into a monomaniacal channel, the more it is impaired in regard to overcoming unforeseen difficulties, just as happened for thousands of centuries.

The worry that AGIs are uniquely dangerous because they could run on ever better hardware is a fallacy, since human thought will be accelerated by the same technology. We have been using tech-assisted thought since the invention of writing and tallying. Much the same holds for the worry that AGIs might get so good, qualitatively, at thinking, that humans would be to them as insects are to humans. All thinking is a form of computation, and any computer whose repertoire includes a universal set of elementary operations can emulate the computations of any other. Hence human brains can think anything that AGIs can, subject only to limitations of speed or memory capacity, both of which can be equalized by technology.

Those are the simple dos and don'ts of coping with AGIs. But how do we create an AGI in the first place? Could we cause them to evolve from a population of ape-type AIs in a virtual environment? If such an experiment succeeded, it would be the most immoral in history, for we don't know how to achieve that outcome without creating vast suffering along the way. Nor do we know how to prevent the evolution of a static culture.

Elementary introductions to computers explain them as TOM, the Totally Obedient Moron—an inspired acronym that captures the essence of all computer programs to date: They have no idea what they are doing or why. So it won't help to give AIs more and more predetermined functionalities in the hope that these will eventually constitute Generality—the elusive G in AGI. We are aiming for the opposite, a DATA: a Disobedient Autonomous Thinking Application.

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How does one test for *thinking*? By the Turing Test? Unfortunately, that requires a thinking judge. One might imagine a vast collaborative project on the Internet, where an AI hones its thinking abilities in conversations with human judges and becomes an AGI. But that assumes, among other things, that the longer the judge is unsure whether the program is a person, the closer it is to being a person. There is no reason to expect that.

And how does one test for *disobedience*? Imagine Disobedience as a compulsory school subject, with daily disobedience lessons and a disobedience test at the end of term. (Presumably with extra credit for not turning up for any of that.) This is paradoxical.

So, despite its usefulness in other applications, the programming technique of defining a testable objective and training the program to meet it will have to be dropped. Indeed, I expect that *any* testing in the process of creating an AGI risks being counterproductive, even immoral, just as in the education of humans. I share Turing's supposition that we'll know an AGI when we see one, but this partial ability to recognize success won't help in creating the successful program.

In the broadest sense, a person's quest for understanding is indeed a search problem, in an abstract space of ideas far too large to be searched exhaustively. But there is no predetermined objective of this search. There is, as Popper put it, no criterion of truth, nor of probable truth, especially in regard to explanatory knowledge. Objectives are ideas like any others—created as part of the search and continually modified and improved. So inventing ways of disabling the program's access to most of the space of ideas won't help—whether that disability is inflicted with the thumbscrew and stake or a mental straitjacket. To an AGI, the whole space of ideas must be open. It should not be knowable in advance what ideas the program can never contemplate. And the ideas that the program does contemplate must be chosen by the program itself, using methods, criteria, and objectives that are also the program's own. Its choices, like an AI's, will be hard to predict without running it (we lose no generality by assuming that the program is deterministic; an AGI using a random generator would remain an AGI if the generator were replaced by a pseudo-random one), but it will have the additional property that there is no way of proving, from its initial state, what it *won't* eventually think, short of running it.

The evolution of our ancestors is the only known case of thought starting up anywhere in the universe. As I have described, something went horribly wrong, and there was no immediate explosion of innovation: Creativity was diverted into something else. Yet not into transforming the planet into paper clips (*pace* Nick Bostrom). Rather, as we should also expect if an AGI project gets that far and fails, perverted creativity was unable to solve unexpected problems. This caused stasis and worse, thus tragically delaying the transformation of anything into anything. But the Enlightenment has happened since then. We know better now.

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Tom Griffiths' *approach to the AI issue of "value alignment"—the study of how, exactly, we can keep the latest of our serial models of AI from turning the planet into paper clips—is human-centered; i.e., that of a cognitive scientist, which is what he is. The key to machine learning, he believes, is, necessarily, human learning, which he studies at Princeton using mathematical and computational tools.*

Tom once remarked to me that "one of the mysteries of human intelligence is that we're able to do so much with so little." Like machines, human beings use algorithms to make decisions or solve problems; the remarkable difference lies in the human brain's overall level of success despite the comparative limits on computational resources.

The efficacy of human algorithms springs from what AI researchers refer to as "bounded optimality." As psychologist Daniel Kahneman has notably pointed out, human beings are rational only up to a point. If you were perfectly rational, you would risk dropping dead before making an important decision—whom to hire, whom to marry, and so on—depending on the number of options available for your review.

"With all of the successes of AI over the last few years, we've got good models of things like images and text, but what we're missing are good models of people," Tom says. "Human beings are still the best example we have of thinking machines. By identifying the quantity and the nature of the preconceptions that inform human cognition we can lay the groundwork for bringing computers even closer to human performance."

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THE ARTIFICIAL USE OF HUMAN BEINGS
Tom Griffiths

Tom Griffiths *is Henry R. Luce Professor of Information, Technology, Consciousness, and Culture at Princeton University. He is co-author (with Brian Christian) of* Algorithms to Live By.

When you ask people to imagine a world that has successfully, beneficially incorporated advances in artificial intelligence, everybody probably comes up with a slightly different picture. Our idiosyncratic visions of the future might differ in the presence or absence of spaceships, flying cars, or humanoid robots. But one thing doesn't vary: the presence of human beings. That's certainly what Norbert Wiener imagined when he wrote about the potential of machines to improve human society by interacting with humans and helping to mediate their interactions with one another. Getting to that point doesn't just require coming up with ways to make machines smarter. It also requires a better understanding of how human minds work.

Recent advances in artificial intelligence and machine learning have resulted in systems that can meet or exceed human abilities in playing games, classifying images, or processing text. But if you want to know why the driver in front of you cut you off, why people vote against their interests, or what birthday present you should get for your partner, you're still better off asking a human than a machine. Solving those problems requires building models of human minds that can be implemented inside a computer—something that's essential not just to better integrate machines into human societies but to make sure that human societies can continue to exist.

Consider the fantasy of having an automated intelligent assistant that can take on such basic tasks as planning meals and ordering groceries. To succeed in these tasks, it needs to be able to make inferences about what you want, based on the way you behave. Although this seems simple, making inferences about the preferences of human beings can be a tricky matter. For example, having observed that the part of the meal you most enjoy is dessert, your assistant might start to plan meals consisting entirely of desserts. Or perhaps it has heard your complaints about never having enough free time and observed that looking after your dog takes up a considerable amount of that free time. Following the dessert debacle, it has also understood that you prefer meals that incorporate protein, so it might begin to research recipes that call for dog meat. It's not a long journey from examples like this to situations that begin to sound like problems for the future of humanity (all of whom are good protein sources).

Making inferences about what humans want is a prerequisite for solving the AI problem of value alignment—aligning the values of an automated intelligent system with those of a human being. Value alignment is important if we want to ensure that those automated intelligent systems have our best interests at heart. If they can't infer what we value, there's no way for them to act in support of those values—and they may well act in ways that contravene them.

Value alignment is the subject of a small but growing literature in artificial-intelligence research. One of the tools used for solving this problem is inverse-reinforcement learning. Reinforcement learning is a standard method for training intelligent machines. By associating particular outcomes with rewards, a machine-

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learning system can be trained to follow strategies that produce those outcomes. Wiener hinted at this idea in the 1950s, but the intervening decades have developed it into a fine art. Modern machine-learning systems can find extremely effective strategies for playing computer games—from simple arcade games to complex real-time strategy games—by applying reinforcement-learning algorithms. Inverse reinforcement learning turns this approach around: By observing the actions of an intelligent agent that has already learned effective strategies, we can infer the rewards that led to the development of those strategies.

In its simplest form, inverse reinforcement learning is something people do all the time. It's so common that we even do it unconsciously. When you see a co-worker go to a vending machine filled with potato chips and candy and buy a packet of unsalted nuts, you infer that your co-worker (1) was hungry and (2) prefers healthy food. When an acquaintance clearly sees you and then tries to avoid encountering you, you infer that there's some reason they don't want to talk to you. When an adult spends a lot of time and money in learning to play the cello, you infer that they must really like classical music—whereas inferring the motives of a teenage boy learning to play an electric guitar might be more of a challenge.

Inverse reinforcement learning is a statistical problem: We have some data—the behavior of an intelligent agent—and we want to evaluate various hypotheses about the rewards underlying that behavior. When faced with this question, a statistician thinks about the generative model behind the data: What data would we expect to be generated if the intelligent agent was motivated by a particular set of rewards? Equipped with the generative model, the statistician can then work backward: What rewards would likely have caused the agent to behave in that particular way?

If you're trying to make inferences about the rewards that motivate human behavior, the generative model is really a theory of how people behave—how human minds work. Inferences about the hidden causes behind the behavior of other people reflect a sophisticated model of human nature that we all carry around in our heads. When that model is accurate, we make good inferences. When it's not, we make mistakes. For example, a student might infer that his professor is indifferent to him if the professor doesn't immediately respond to his email—a consequence of the student's failure to realize just how many emails that professor receives.

Automated intelligent systems that will make good inferences about what people want must have good generative models for human behavior: that is, good models of human cognition expressed in terms that can be implemented on a computer. Historically, the search for computational models of human cognition is intimately intertwined with the history of artificial intelligence itself. Only a few years after Norbert Wiener published *The Human Use of Human Beings*, Logic Theorist, the first computational model of human cognition and also the first artificial-intelligence system, was developed by Herbert Simon, of Carnegie Tech, and Allen Newell, of the RAND Corporation. Logic Theorist automatically produced mathematical proofs by emulating the strategies used by human mathematicians.

The challenge in developing computational models of human cognition is making models that are both accurate and generalizable. An accurate model, of course, predicts human behavior with a minimum of errors. A generalizable model can make predictions across a wide range of circumstances, including circumstances unanticipated by its

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creators—for instance, a good model of the Earth's climate should be able to predict the consequences of a rising global temperature even if this wasn't something considered by the scientists who designed it. However, when it comes to understanding the human mind, these two goals—accuracy and generalizability—have long been at odds with each other.

At the far extreme of generalizability are rational theories of cognition. These theories describe human behavior as a rational response to a given situation. A rational actor strives to maximize the expected reward produced by a sequence of actions—an idea widely used in economics precisely *because* it produces such generalizable predictions about human behavior. For the same reason, rationality is the standard assumption in inverse-reinforcement-learning models that try to make inferences from human behavior—perhaps with the concession that humans are not perfectly rational agents and sometimes randomly choose to act in ways unaligned with or even opposed to their best interests.

The problem with rationality as a basis for modeling human cognition is that it is not accurate. In the domain of decision making, an extensive literature—spearheaded by the work of cognitive psychologists Daniel Kahneman and Amos Tversky—has documented the ways in which people deviate from the prescriptions of rational models. Kahneman and Tversky proposed that in many situations people instead follow simple heuristics that allow them to reach good solutions at low cognitive cost but sometimes result in errors. To take one of their examples, if you ask somebody to evaluate the probability of an event, they might rely on how easy it is to generate an example of such an event from memory, consider whether they can come up with a causal story for that event's occurring, or assess how similar the event is to their expectations. Each heuristic is a reasonable strategy for avoiding complex probabilistic computations, but also results in errors. For instance, relying on the ease of generating an event from memory as a guide to its probability leads us to overestimate the chances of extreme (hence extremely memorable) events such as terrorist attacks.

Heuristics provide a more accurate model of human cognition but one that is not easily generalizable. How do we know which heuristic people might use in a particular situation? Are there other heuristics they use that we just haven't discovered yet? Knowing exactly how people will behave in a new situation is a challenge: Is this situation one in which they would generate examples from memory, come up with causal stories, or rely on similarity?

Ultimately, what we need is a way to describe how human minds work that has the generalizability of rationality and the accuracy of heuristics. One way to achieve this goal is to start with rationality and consider how to take it in a more realistic direction. A problem with using rationality as a basis for describing the behavior of any real-world agent is that, in many situations, calculating the rational action requires the agent to possess a huge amount of computational resources. It might be worth expending those resources if you're making a highly consequential decision and have a lot of time to evaluate your options, but most human decisions are made quickly and for relatively low stakes. In any situation where the time you spend making a decision is costly—at the very least because it's time you could spend doing something else—the classic notion of rationality is no longer a good prescription for how one should behave.

To develop a more realistic model of rational behavior, we need to take into

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account the cost of computation. Real agents need to modulate the amount of time they spend thinking by the effect the extra thought has on the results of a decision. If you're trying to choose a toothbrush, you probably don't need to consider all four thousand listings for manual toothbrushes on Amazon.com before making a purchase: You trade off the time you spend looking with the difference it makes in the quality of the outcome. This trade-off can be formalized, resulting in a model of rational behavior that artificial-intelligence researchers call "bounded optimality." The bounded-optimal agent doesn't focus on always choosing exactly the right action to take but rather on finding the right algorithm to follow in order to find the perfect balance between making mistakes and thinking too much.

Bounded optimality bridges the gap between rationality and heuristics. By describing behavior as the result of a rational choice about how much to think, it provides a generalizable theory—that is, one that can be applied in new situations. Sometimes the simple strategies that have been identified as heuristics that people follow turn out to be bounded-optimal solutions. So, rather than condemning the heuristics that people use as irrational, we can think of them as a rational response to constraints on computation.

Developing bounded optimality as a theory of human behavior is an ongoing project that my research group and others are actively pursuing. If these efforts succeed, they will provide us with the most important ingredient we need for making artificial-intelligence systems smarter when they try to interpret people's actions, by enabling a generative model for human behavior.

Taking into account the computational constraints that factor into human cognition will be particularly important as we begin to develop automated systems that aren't subject to the same constraints. Imagine a superintelligent AI system trying to figure out what people care about. Curing cancer or confirming the Riemann hypothesis, for instance, won't seem, to such an AI, like things that are all that important to us: If these solutions are obvious to the superintelligent system, it might wonder why we haven't found them ourselves, and conclude that those problems don't mean much to us. If we cared and the problems were so simple, we would have solved them already. A reasonable inference would be that we do science and math purely because we enjoy doing science and math, not because we care about the outcomes.

Anybody who has young children can appreciate the problem of trying to interpret the behavior of an agent that is subject to computational constraints different from one's own. Parents of toddlers can spend hours trying to disentangle the true motivations behind seemingly inexplicable behavior. As a father and a cognitive scientist, I found it was easier to understand the sudden rages of my two-year-old when I recognized that she was at an age where she could appreciate that different people have different desires but not that other people might not know what her own desires were. It's easy to understand, then, why she would get annoyed when people didn't do what she (apparently transparently) wanted. Making sense of toddlers requires building a cognitive model of the mind of a toddler. Superintelligent AI systems face the same challenge when trying to make sense of human behavior.

Superintelligent AI may still be a long way off. In the short term, devising better models of people can prove extremely valuable to any company that makes money by analyzing human behavior—which at this point is pretty much every company that does business on the Web. Over the last few years, significant new commercial technologies

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for interpreting images and text have resulted from developing good models for vision and language. Developing good models of people is the next frontier.

Of course, understanding how human minds work isn't just a way to make computers better at interacting with people. The trade-off between making mistakes and thinking too much that characterizes human cognition is a trade-off faced by any real-world intelligent agent. Human beings are an amazing example of systems that act intelligently despite significant computational constraints. We're quite good at developing strategies that allow us to solve problems pretty well without working too hard. Understanding how we do this will be a step toward making computers work smarter, not harder.

HOUSE_OVERSIGHT_016316

Romanian-born **Anca Dragan's** *research focuses on algorithms that will enable robots to work with, around, and in support of people. She runs the InterACT Laboratory at Berkeley, where her students work across different applications, from assistive robots to manufacturing to autonomous cars, and draw from optimal control, planning, estimation, learning, and cognitive science. Barely into her thirties herself, she has co-authored a number of papers with her veteran Berkeley colleague and mentor Stuart Russell which address various aspects of machine learning and the knotty problems of value alignment.*

She shares Stuart's preoccupation with AI safety: "An immediate risk is agents producing unwanted, surprising behavior," she told an interviewer from the Future of Life Institute. "Even if we plan to use AI for good, things can go wrong, precisely because we are bad at specifying objectives and constraints for AI agents. Their solutions are often not what we had in mind."

Her principal goal is therefore to help robots and programmers alike to overcome the many conflicts that arise because of a lack of transparency about each other's intentions. Robots, she says, need to ask us questions. They should wonder about their assignments, and they should pester their human programmers until everybody is on the same page—so as to avoid what she has euphemistically called "unexpected side effects."

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PUTTING THE HUMAN INTO THE AI EQUATION

Anca Dragan

Anca Dragan *is an assistant professor in the Department of Electrical Engineering and Computer Sciences at UC Berkeley. She co-founded and serves on the steering committee for the Berkeley AI Research (BAIR) Lab and is a co-principal investigator in Berkeley's Center for Human-Compatible AI.*

At the core of artificial intelligence is our mathematical definition of what an AI agent (a robot) is. When we define a robot, we define states, actions, and rewards. Think of a delivery robot, for instance. States are locations in the world, and actions are motions that the robot makes to get from one position to a nearby one. To enable the robot to decide on which actions to take, we define a reward function—a mapping from states and actions to scores indicating how good that action was in that state—and have the robot choose actions that accumulate the most "reward." The robot gets a high reward when it reaches its destination, and it incurs a small cost every time it moves; this reward function incentivizes the robot to get to the destination as quickly as possible. Similarly, an autonomous car might get a reward for making progress on its route and incur a cost for getting too close to other cars.

Given these definitions, a robot's job is to figure out what actions it should take in order to get the highest cumulative reward. We've been working hard in AI on enabling robots to do just that. Implicitly, we've assumed that if we're successful—if robots can take any problem definition and turn into a policy for how to act—we will get robots that are useful to people and to society.

We haven't been too wrong so far. If you want an AI that classifies cells as either cancerous or benign, or a robot that vacuums the living room rug while you're at work, we've got you covered. Some real-world problems can indeed be defined in isolation, with clear-cut states, actions, and rewards. But with increasing AI capability, the problems we want to tackle don't fit neatly into this framework. We can no longer cut off a tiny piece of the world, put it in a box, and give it to a robot. Helping people is starting to mean working in the real world, where you have to actually interact with people and reason about them. "People" will have to formally enter the AI problem definition somewhere.

Autonomous cars are already being developed. They will need to share the road with human-driven vehicles and pedestrians and learn to make the trade-off between getting us home as fast as possible and being considerate of other drivers. Personal assistants will need to figure out when and how much help we really want and what types of tasks we prefer to do on our own versus what we can relinquish control over. A DSS (Decision Support System) or a medical diagnostic system will need to explain its recommendations to us so we can understand and verify them. Automated tutors will need to determine what examples are informative or illustrative—not to their fellow machines but to us humans.

Looking further into the future, if we want highly capable AIs to be compatible with people, we can't create them in isolation from people and then try to make them compatible afterward; rather, we'll have to define "human-compatible" AI from the get-go. People can't be an afterthought.

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When it comes to real robots helping real people, the standard definition of AI fails us, for two fundamental reasons: First, optimizing the robot's reward function in isolation is different from optimizing it when the robot acts around people, because people take actions too. We make decisions in service of our own interests, and these decisions dictate what actions we execute. Moreover, we reason about the robot—that is, we respond to what we think it's doing or will do and what we think its capabilities are. Whatever actions the robot decides on need to mesh well with ours. This is the *coordination problem*.

Second, it is ultimately a human who determines what the robot's reward function should be in the first place. And they are meant to incentivize robot behavior that matches what the end-user wants, what the designer wants, or what society as a whole wants. I believe that capable robots that go beyond very narrowly defined tasks will need to understand this to achieve compatibility with humans. This is the *value-alignment problem.*

The Coordination Problem: People are more than objects in the environment.
When we design robots for a particular task, it's tempting to abstract people away. A robotic personal assistant, for example, needs to know how to move to pick up objects, so we define that problem in isolation from the people for whom the robot is picking these objects up. Still, as the robot moves around, we don't want it bumping into anything, and that includes people, so we might include the physical location of the person in the definition of the robot's state. Same for cars: We don't want them colliding with other cars, so we enable them to track the positions of those other cars and assume that they'll be moving consistently in the same direction in the future. A human being, in this sense, is no different to a robot from a ball rolling on a flat surface. The ball will behave in the next few seconds the same way it behaved in the past few; it keeps rolling in the same direction at roughly the same speed. This is of course nothing like real human behavior, but such simplification enables many robots to succeed in their tasks and, for the most part, stay out of people's way. A robot in your house, for example, might see you coming down the hall, move aside to let you pass, and resume its task once you've gone by.

As robots have become more capable, though, treating people as consistently moving obstacles is starting to fall short. A human driver switching lanes won't continue in the same direction but will move straight ahead once they've made the lane change. When you reach for something, you often reach around other objects and stop when you get to the one you want. When you walk down a hallway, you have a destination in mind: You might take a right into the bedroom or a left into the living room. Relying on the assumption that we're no different from a rolling ball leads to inefficiency when the robot stays out of the way if it doesn't need to, and it can imperil the robot when the person's behavior changes. Even just to stay out of the way, robots have to be somewhat accurate at anticipating human actions. And, unlike the rolling ball, what people will do depends on what they *decide* to do. So to anticipate human actions, robots need to start understanding human decision making. And that doesn't mean assuming that human behavior is perfectly optimal; that might be enough for a chess- or Go-playing robot, but in the real world, people's decisions are less predictable than the optimal move in a board game.

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This need to understand human actions and decisions applies to physical and nonphysical robots alike. If either sort bases its decision about how to act on the assumption that a human will do one thing but the human does something else, the resulting mismatch could be catastrophic. For cars, it can mean collisions. For an AI with, say, a financial or economic role, the mismatch between what it expects us to do and what we actually do could have even worse consequences.

One alternative is for the robot not to predict human actions but instead just protect against the *worst-case* human action. Often when robots do that, though, they stop being all that useful. With cars, this results in being stuck, because it makes every move too risky.

All this puts us, the AI community, into a bind. It suggests that robots will need accurate (or at least reasonable) predictive models of whatever people might decide to do. Our state definition can't just include the physical position of humans in the world. Instead, we'll also need to estimate something *internal* to people. We'll need to design robots that account for this human internal state, and that's a tall order. Luckily, people tend to give robots hints as to what their internal state is: Their ongoing actions give the robot observations (in the Bayesian inference sense) about their intentions. If we start walking toward the right side of the hallway, we're probably going to enter the next room on the right.

What makes the problem more complicated is the fact that people don't make decisions in isolation. It would be one thing if robots could predict the actions a person intends to take and simply figure out what to do in response. But unfortunately this can lead to ultra-defensive robots that confuse the heck out of people. (Think of human drivers stuck at four-way stops, for instance.) What the intent-prediction approach misses is that the moment the robot acts, that influences what actions the human starts taking.

There is a mutual influence between robots and people, one that robots will need to learn to navigate. It is not always just about the robot planning around people; people plan around the robot, too. It is important for robots to account for this when deciding which actions to take, be it on the road, in the kitchen, or even in virtual spaces, where actions might be making a purchase or adopting a new strategy. Doing so should endow robots with *coordination* strategies, enabling them to take part in the negotiations people seamlessly carry out day to day—from who goes first at an intersection or through a narrow door, to what role we each take when we collaborate on preparing breakfast, to coming to consensus on what next step to take on a project.

Finally, just as robots need to anticipate what people will do next, people need to do the same with robots. This is why transparency is important. Not only will robots need good mental models of people, but people will need good mental models of robots. The model that a person has of the robot has to go into our state definition as well, and the robot has to be aware of how its actions are changing that model. Much like the robot treating human actions as clues to human internal states, people will change their beliefs about the robot as they observe its actions. Unfortunately, the giving of clues doesn't come as naturally to robots as it does to humans; we've had a lot of practice communicating implicitly with people. But enabling robots to account for the change that their actions are causing to the person's mental model of the robot can lead to more carefully chosen actions that do give the right clues—that clearly communicate to people about the robot's intentions, its reward function, its limitations. For instance, a robot

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might alter its motion when carrying something heavy, to emphasize the difficulty it has in maneuvering heavy objects. The more that people know about the robot, the easier it is to coordinate with it.

Achieving action compatibility will require robots to anticipate human actions, account for how those actions will influence their own, and enable people to anticipate robot actions. Research has ,ade a degree of progress in meeting these challenges, but we still have a long way to go.

The Value Alignment Problem: People hold the key to the robot's reward function. Progress on enabling robots to optimize reward puts more burden on us, the designers, to give them the right reward to optimize in the first place. The original thought was that for any task we wanted the robot to do, we could write down a reward function that incentivizes the right behavior. Unfortunately, what often happens is that we specify some reward function and the behavior that emerges out of optimizing it isn't what we want. Intuitive reward functions, when combined with unusual instances of a task, can lead to unintuitive behavior. You reward an agent in a racing game with a score in the game, and in some cases it finds a loophole that it exploits to gain infinitely many points without actually winning the race. Stuart Russell and Peter Norvig give a beautiful example in their book *Artificial Intelligence: A Modern Approach:* rewarding a vacuuming robot for how much dust it sucks in results in the robot deciding to dump out dust so that it can suck it in again and get more reward.

In general, humans have had a notoriously difficult time specifying exactly what they want, as exemplified by all those genie legends. An AI paradigm in which robots get some externally specified reward fails when that reward is not perfectly well thought out. It may incentivize the robot to behave in the wrong way and even resist our attempts to correct its behavior, as that would lead to a lower specified reward.

A seemingly better paradigm might be for robots to optimize for what we internally want, even if we have trouble explicating it. They would use what we say and do as evidence about what we want, rather than interpreting it literally and taking it as a given. When we write down a reward function, the robot should understand that we might be wrong: that we might not have considered all facets of the task; that there's no guarantee that said reward function will *always* lead to the behavior we want. The robot should integrate what we wrote down into its understanding of what we want, but it should also have a back-and-forth with us to elicit clarifying information. It should seek our guidance, because that's the only way to optimize the true desired reward function.

Even if we give robots the ability to learn what we want, an important question remains that AI alone won't be able to answer. We can make robots try to align with a person's internal values, but there's more than one person involved here. The robot has an end-user (or perhaps a few, like a personal robot caring for a family, a car driving a few passengers to different destinations, or an office assistant for an entire team); it has a designer (or perhaps a few); and it interacts with society—the autonomous car shares the road with pedestrians, human-driven vehicles, and other autonomous cars. How to combine these people's values when they might be in conflict is an important problem we need to solve. AI research can give us the tools to combine values in any way we decide but can't make the necessary decision for us.

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In short, we need to enable robots to reason about us—to see us as something more than obstacles or perfect game players. We need them to take our human nature into account, so that they are well coordinated and well aligned with us. If we succeed, we will indeed have tools that substantially increase our quality of life.

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Chris Anderson's *company, 3DR, helped start the modern drone industry and now focuses on drone data software. He got his start building an open-source aerial robotics community called DIY Drones, and undertook some ill-advised early experiments, such as buzzing Lawrence Berkeley Laboratory with one of his self-flying spies. It may well have been a case of antic gene-expression, since he's descended from a founder of the American Anarchist movement. Chris ran* Wired *magazine, a go-to publication for techno-utopians and -dystopians alike, from 2001 to 2012; during his tenure it won five National Magazine Awards.*

Chris dislikes the term "roboticist" ("like any properly humbled roboticist, I don't call myself one"). He began as a physicist. "I turned out to be a bad physicist," he told me recently. "I struggled on, went to Los Alamos, and thought, 'Well maybe I'm not going to be a Nobel Prize winner, but I can still be a scientist.' All of us who were in physics and had these romantic heroes—the Feynmans, the Manhattan Project—realized that our career trajectory would at best be working on one project at CERN for fifteen years. That project would either be a failure, in which case there would be no paper, or it would be a success, in which case you'd be author #300 on the paper and become an assistant professor at Iowa State.

"Most of my classmates went to Wall Street to become quants, and to them we owe the subprime mortgage. Others went on to start the Internet. First, we built the Internet by connecting physics labs; second, we built the Web; third, we were the first to do Big Data. We had supercomputers—Crays—which were half the power of your phone now, but they were the supercomputers of the time. Meanwhile, we were reading this magazine called Wired, *which came out in 1993, and we realized that this tool we scientists use could have applications for everybody. The Internet wasn't just about scientific data, it was a mind-blowing cultural revolution. So when Conde Nast asked me to take over the magazine, I was like, 'Absolutely!' This magazine changed my life."*

He had five children by that time—video-game players—who got him into the "flying robots." He quit his day job at Wired. *The rest is Silicon Valley history.*

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GRADIENT DESCENT
Chris Anderson

***Chris Anderson** is an entrepreneur; former editor-in-chief of* Wired; *co-founder and CEO of 3DR; and author of* The Long Tail, Free, *and* Makers.

Life

The mosquito first detects my scent from thirty feet away. It triggers its pursuit function, which consists of the simplest possible rules. First, move in a random direction. If the scent increases, continue moving in that direction. If the scent decreases, move in the opposite direction. If the scent is lost, move sideways until a scent is picked up again. Repeat until contact with the target is achieved.

The plume of my scent is densest next to me and disperses as it spreads, an invisible fog of particles exuded from my skin that moves like smoke with the wind. The closer to my skin, the higher the particle density; the farther away, the lower. This decrease is called a gradient, which describes any gradual transition from one level to another one—as opposed to a "step function," which describes a discrete change.

Once the mosquito follows this gradient to its source using its simple algorithm, it lands on my skin, which it senses with the heat detectors in its feet, which are attuned to another gradient—temperature. It then pushes its needle-shaped proboscis through the surface, where a third set of sensors in the tip detect yet another gradient, that of blood density. This flexible needle wriggles around under my skin until the scent of blood steers it to a capillary, which it punctures. Then my blood begins to flow into the mosquito. Mission accomplished. Ouch.

What seems like the powerful radar of insects in the dark, with blood-seeking intelligence inexplicable for such tiny brains, is actually just a sensitive nose with almost no intelligence at all. Mosquitoes are closer to plants that follow the sun than to guided missiles. Yet by applying this simple "follow your nose" rule quite literally, they can travel through a house to find you, slip through cracks in a screen door, even zero in on the tiny strip of skin you left exposed between hat and shirt collar. It's just a random walk, combined with flexible wings and legs that let the insect bounce off obstacles, and an instinct to descend a chemical gradient.

But "gradient descent" is much more than bug navigation. Look around you and you'll find it everywhere, from the most basic physical rules of the universe to the most advanced artificial intelligence.

The Universe

We live in a world of countless gradients, from light and heat to gravity and chemical trails (chemtrails!). Water flows along a gravity gradient downhill, and your body lives on chemical solutions flowing across cell membranes from high concentration to low. Every action in the universe is driven by some gradient drive, from the movement of the planets around gravity gradients to the joining of atoms along electric-charge gradients to form molecules. Our own urges, such as hunger and sleepiness, are driven by electro-chemical gradients in our bodies. And our brain's functions, the electrical signals moving along ion channels in the synapses between our neurons, are simply atoms and electrons flowing "downhill" along yet more electrical and chemical gradients.

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Forget clockwork analogies; our brains are closer to a system of canals and locks, with signals traveling like water from one state to another.

As I sit here typing, I'm actually seeking equilibrium states in an *n*-dimensional topology of gradients. Take just one: heat. My body temperature is higher than the air temperature, so I radiate heat, which must be replenished in my core. Even the bacteria in my digestive tract use sensors to measure sugar concentrations in the liquid around them and whip their tail-like flagella to swim "upstream" where the sugar supply is richest. The natural state of all systems is to flow to lower energy states, a process that is broadly described by entropy (the tendency of things to go from ordered to disordered states; all things will fall apart eventually, including the universe itself).

But how do you explain more complex behavior, such as our ability to make decisions? The answer is just more gradient descent.

Our Brains

As miraculous and inscrutable as our human intelligence is, science is coming around to the view that our brains operate the same way as any other complex system with layers and feedback loops, all pursuing what we mathematically call "optimization functions" but you could just as well call "flowing downhill" in some sense.

The essence of intelligence is learning, and we do that by correlating inputs with positive or negatives scores (rewards or punishment). So, for a baby, "this sound" (your mother's voice) is associated with other learned connections to your mother, such as food or comfort. Likewise, "this muscle motion brings my thumb closer to my mouth." Over time and trial and error, the brain's neural network reinforces those connections. Meanwhile "this muscle motion does not bring my thumb close to my mouth" is a negative correlation, and the brain will weaken those connections.

However, this is too simplistic. The limits of gradient descent constitute the so-called local-minima problem (or local-maxima problem, if you're doing a gradient *ascent*). If you are walking in a mountainous region and want to get home, always walking downhill will most likely get you to the next valley but not necessarily over the other mountains that lie around it and between you and home. For that, you need either a mental model (i.e., a map) of the topology so you know where to ascend to get out of the valley, or you need to switch between gradient descent and random walks so you can bounce your way out of the region.

Which is, in fact, exactly what the mosquito does in following my scent: It descends when it's in my plume and random-walks when it has lost the trail or hit an obstacle.

AI

So that's nature. What about computers? Traditional software doesn't work that way—it follows deterministic trees of hard logic: "If this, do that." But software that interacts with the physical world tends to work more *like* the physical world. That means dealing with noisy inputs (sensors or human behavior) and providing probabilistic, not deterministic, results. And that, in turn, means more gradient descent.

AI software is the best example of this, especially the kinds of AI that use artificial neural-network models (including convolutional, or "deep," neural networks of many layers). In these, a typical process consists of "training" them by showing them

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lots of examples of something you want them to learn (pictures of cats labeled "cat," for example), along with examples of other random data (pictures of other things). This is called "supervised learning," because the neural network is being taught by example, including the use of "adversarial training" with data that is not correlated to the desired result.

These neural networks, like their biological models, consist of layers of thousands of nodes ("neurons," in the analogy), each of which is connected to all the nodes in the layers above and below by connections that initially have random strength. The top layer is presented with data, and the bottom layer is given the correct answer. Any series of connections that happened to land on the right answer is made stronger ("rewarded"), and those that were wrong are made weaker ("punished"). Repeat tens of thousands of times and eventually you have a fully trained network for that kind of data.

You can think of all the possible combinations of connections as like the surface of a planet, with hills and valleys. (Ignore for the moment that the surface is just 3D and the actual topology is many-dimensional.) The optimization that the network goes through as it learns is just a process of finding the deepest valley on the planet. This consists of the following steps:

1. Define a "cost function" that determines how well the network solved the problem
2. Run the network once and see how it did at that cost function
3. Change the values of the connections and do it again. The difference between those two results is the direction, or "slope," in which the network moved between the two trials.
4. If the slope is pointed "downhill," change the connections more in that direction. If it's "uphill," change them in the opposite direction.
5. Repeat until there is no improvement in any direction. That means that you're in a minimum.

Congrats! But it's probably a *local* minimum, or a little dip in the mountains, so you're going to have to keep going if you want to do better. You can't keep going downhill, and you don't know where the absolute lowest point is, so you're going to have to somehow find it. There are many ways to do that, but here are a few:

1. Try lots of times with different random settings and share learning from each trial; essentially, you are shaking the system to see if it settles in a lower state. If one of the other trials found a lower valley, start with those settings.
2. Don't just go downhill but stumble around a bit like a drunk, too (this is called "stochastic gradient descent"). If you do this long enough, you'll eventually find rock bottom. There's a metaphor for life in that.
3. Just look for "interesting" features, which are defined by diversity (edges or color changes, for example). Warning: This way can lead to madness—too much "interestingness" draws the network to optical illusions. So keep it sane, and emphasize the kinds of features that are likely to be real in nature, as opposed to artifacts or errors. This is called "regularization," and there are lots of techniques for this, such as whether those kinds of features have been seen before (learned),

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or are too "high frequency" (like static) rather than "low frequency" (more continuous, like actual real-world features).

Just because AI systems sometimes end up in local minima, don't conclude that this makes them any less like life. Humans—indeed, probably all life-forms—are often stuck in local minima.

Take our understanding of the game of Go, which was taught and learned and optimized by humans for thousands of years. It took AIs less than three years to find out that we'd been playing it wrong all along and that there were better, almost alien, solutions to the game which we'd never considered—mostly because our brains don't have the processing power to consider so many moves ahead.

Even in chess, which is ten times easier and was thought to be understood, brute-force machines could beat us at our own strategies. Chess, too, turned out, when explored by superior neural-network AI systems, to have weird but superior strategies we'd never considered, like sacrificing queens early to gain an obscure long-term advantage. It's as if we had been playing 2D versions of games that actually existed in higher dimensions.

If any of this sounds familiar, it's because physics has been wrestling with these sorts of topological problems for decades. The notion of space being many-dimensional, and math reducing to understanding the geometries and interactions of "membranes" beyond the reach of our senses, is where Grand Unified Theorists go to die. But unlike multidimensional theoretical physics, AI is something we can actually experiment with and measure.

So that's what we're going to do. The next few decades will be an explosive exploration of ways to think that 7 million years of evolution never found. We're going to rock ourselves out of local minima and find deeper minima, maybe even global minima. And when we're done, we may even have taught machines to seem as smart as a mosquito, forever descending the cosmic gradients to an ultimate goal, whatever that may be.

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David Kaiser *is a physicist atypically interested in the intersection of his science with politics and culture, about which he has written widely.*

In the first meeting (in Washington, Connecticut) that preceded the crafting of this book, he commented on the change in how "information" is viewed since Wiener's time: the military-industrial, Cold War era. Back then, Wiener compared information, metaphorically, to entropy, in that it could not be conserved—i.e., monopolized; thus, he argued, our atomic secrets and other such classified matters would not remain secrets for long. Today, whereas (as Wiener might have expected) information, fake or not, is leaking all over the other Washington, information in the economic world has indeed been stockpiled, commodified, and monetized.

This lockdown, David said, was "not all good, not all bad"—depending, I guess, on whether you're sick of being pestered by ads for socks or European river cruises popping up in your browser minutes after you've bought them.

To say nothing of information's proliferation. David complained to the rest of us attending the meeting that in Wiener's time, physicists could "take the entire Physical Review. *It would sit comfortably in front of us in a manageable pile. Now we're awash in fifty thousand open-source journals per minute," full of god-knows-what. Neither of these developments would Wiener have anticipated, said David, prompting him to ask, "Do we need a new set of guiding metaphors?"*

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"INFORMATION" FOR WIENER, FOR SHANNON, AND FOR US

David Kaiser

David Kaiser *is Germeshausen Professor of the History of Science and professor of physics at MIT, and head of its Program in Science, Technology & Society. He is the author of* How the Hippies Saved Physics: Science, Counterculture, and the Quantum Revival *and* American Physics and the Cold War Bubble *(forthcoming).*

In *The Sleepwalkers*, a sweeping history of scientific thought from ancient times through the Renaissance, Arthur Koestler identified a tension that has marked the most dramatic leaps of our cosmological imagination. In reading the great works of Nicolaus Copernicus and Johannes Kepler today, Koestler argued, we are struck as much by their strange unfamiliarity—their embeddedness in the magic or mysticism of an earlier age—as by their modern-sounding insights.

I detect that same doubleness—the zig-zag origami folds of old and new—in Norbert Wiener's classic *The Human Use of Human Beings*. First published in 1950 and revised in 1954, the book is in many ways extraordinarily prescient. Wiener, the MIT polymath, recognized before most observers that "society can only be understood through a study of the messages and the communication facilities which belong to it." Wiener argued that feedback loops, the central feature of his theory of cybernetics, would play a determining role in social dynamics. Those loops would not only connect people with one another but connect people with machines, and—crucially—machines with machines.

Wiener glimpsed a world in which information could be separated from its medium. People, or machines, could communicate patterns across vast distances and use them to fashion new items at the endpoints, without "moving a…particle of matter from one end of the line to the other," a vision now realized in our world of networked 3D printers. Wiener also imagined machine-to-machine feedback loops driving huge advances in automation, even for tasks that had previously relied on human judgment. "The machine plays no favorites between manual labor and white-collar labor," he observed.

For all that, many of the central arguments in *The Human Use of Human Beings* seem closer to the 19th century than the 21st. In particular, although Wiener made reference throughout to Claude Shannon's then-new work on information theory, he seems not to have fully embraced Shannon's notion of information as consisting of irreducible, meaning-free bits. Since Wiener's day, Shannon's theory has come to undergird recent advances in "Big Data" and "deep learning," which makes it all the more interesting to revisit Wiener's cybernetic imagination. How might tomorrow's artificial intelligence be different if practitioners were to re-invest in Wiener's guiding vision of "information"?

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When Wiener wrote *The Human Use of Human Beings*, his experiences of war-related research, and of what struck him as the moral ambiguities of intellectual life amid the military-industrial complex, were still fresh. Just a few years earlier, he had announced

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in the pages of *The Atlantic Monthly* that he would not "publish any future work of mine which may do damage in the hands of irresponsible militarists."[30] He remained ambivalent about the transformative power of new technologies, indulging in neither the boundless hype nor the digital utopianism of later pundits.

"Progress imposes not only new possibilities for the future but new restrictions," he wrote, in *Human Use*. He was concerned about human-made restrictions as well as technological ones, especially Cold War restrictions that threatened the flow of information so critical to cybernetic systems: "Under the impetus of Senator [Joseph] McCarthy and his imitators, the blind and excessive classification of military information" was driving political leaders in the United States to adopt a "secretive frame of mind paralleled in history only in the Venice of the Renaissance." Wiener, echoing many outspoken veterans of the Manhattan Project, argued that the postwar obsession with secrecy—especially around nuclear weapons—stemmed from a misunderstanding of the scientific process. The only genuine secret about the production of nuclear weapons, he wrote, was whether such bombs could be built. Once that secret had been revealed, with the bombings of Hiroshima and Nagasaki, no amount of state-imposed secrecy would stop others from puzzling through chains of reasoning like those the Manhattan Project researchers had followed. As Wiener memorably put it, "There is no Maginot Line of the brain."

To drive this point home, Wiener borrowed Shannon's fresh ideas about information theory. In 1948, Shannon, a mathematician and engineer working at Bell Labs, had published a pair of lengthy articles in the *Bell System Technical Journal*. Introducing the new work to a broad readership in 1949, mathematician Warren Weaver explained that in Shannon's formulation, "the word *information*…is used in a special sense that must not be confused with its ordinary usage. In particular, *information* must not be confused with meaning."[31] Linguists and poets might be concerned about the "semantic" aspects of communication, Weaver continued, but not engineers like Shannon. Rather, "this word 'information' in communication theory relates not so much to what you *do* say, as to what you *could* say." In Shannon's now-famous formulation, the information content of a string of symbols was given by the logarithm of the number of possible symbols from which a given string was chosen. Shannon's key insight was that the information of a message was just like the entropy of a gas: a measure of the system's disorder.

Wiener borrowed this insight when composing *Human Use*. If information was like entropy, then it could not be conserved—or contained. Physicists in the 19th century had demonstrated that the total energy of a physical system must always remain the same, a perfect balance between the start and the end of a process. Not so for entropy, which would inexorably increase over time, an imperative that came to be known as the second law of thermodynamics. From that stark distinction—energy is conserved, whereas entropy must grow—followed enormous cosmic consequences. Time must flow forward;

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[30] Norbert Wiener, "A Scientist Rebels," *The Atlantic Monthly,* January 1947.

[31] Warren Weaver, "Recent Contributions to the Mathematical Theory of Communication," in Claude Shannon & Warren Weaver, *The Mathematical Theory of Communication* (Urbana, IL: University of Illinois Press, 1949), p. 8 (emphasis in original). Shannon's 1948 papers were republished in the same volume.

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the future cannot be the same as the past. The universe could even be careening toward a "heat death," some far-off time when the total stock of energy had uniformly dispersed, achieving a state of maximum entropy, after which no further change could occur.

If information *qua* entropy could not be conserved, then Wiener concluded it was folly for military leaders to try to stockpile the "scientific know-how of the nation in static libraries and laboratories." Indeed, "no amount of scientific research, carefully recorded in books and papers, and then put into our libraries with labels of secrecy, will be adequate to protect us for any length of time in a world where the effective level of information is perpetually advancing." Any such efforts at secrecy, classification, or the containment of information would fail, Wiener argued, just as surely as hucksters' schemes for perpetual-motion machines faltered in the face of the second law of thermodynamics.

Wiener criticized the American "orthodoxy" of free-market fundamentalism in much the same way. For most Americans, "questions of information will be evaluated according to a standard American criterion: a thing is valuable as a commodity for what it will bring in the open market." Indeed, "the fate of information in the typically American world is to become something which can be bought or sold;" most people, he observed, "cannot conceive of a piece of information without an owner." Wiener considered this view to be as wrong-headed as rampant military classification. Again he invoked Shannon's insight: Since "information and entropy are not conserved," they are "equally unsuited to being commodities."

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Information cannot be conserved—so far, so good. But did Wiener really have Shannon's "information" in mind? The crux of Shannon's argument, as Weaver had emphasized, was to distinguish a colloquial sense of "information," as message with meaning, from an abstracted, rarefied notion of strings of symbols arrayed with some probability and selected from an enormous universe of gibberish. For Shannon, "information" could be quantified because its fundamental unit, the bit, was a unit of conveyance rather than understanding.

When Wiener characterized "information" throughout *Human Use*, on the other hand, he tilted time and again to a classical, humanistic sense of the term. "A piece of information," he wrote—tellingly, not a "bit" of information—"in order to contribute to the general information of the community, must say something substantially different from the community's previous common stock of information." This was why "schoolboys do not like Shakespeare," he concluded: The Bard's couplets may depart starkly from random bitstreams, but they had nonetheless become all too familiar to the sense-making public and "absorbed into the superficial clichés of the time."

At least the information content of Shakespeare had once seemed fresh. During the postwar boom years, Wiener fretted, the "enormous per capita bulk of communication"—ranging across newspapers and movies to radio, television, and books—had bred mediocrity, an informational reversion to the mean. "More and more we must accept a standardized inoffensive and insignificant product which, like the white bread of the bakeries, is made rather for its keeping and selling properties than for its food value." "Heaven save us," he pleaded, "from the first novels which are written because a young man desires the prestige of being a novelist rather than because he has

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something to say! Heaven save us likewise from the mathematical papers which are correct and elegant but without body or spirit." Wiener's treatment of "information" sounded more like Matthew Arnold in 1869[32] than Claude Shannon in 1948—more "body and spirit" than "bit." Wiener shared Arnold's Romantic view of the "content producer" as well. "Properly speaking the artist, the writer, and the scientist should be moved by such an irresistible impulse to create that, even if they were not being paid for their work, they would be willing to pay to get the chance to do it." *L'art pour l'art*, that 19th-century cry: Artists should suffer for their work; the quest for meaningful expression should always trump lucre.

To Wiener, this was the proper measure of "information": body, spirit, aspiration, expression. Yet to argue against its commodification, Wiener reverted again to Shannon's mathematics of information-as-entropy.

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Flash forward to our day. In many ways, Wiener has been proved right. His vision of networked feedback loops driven by machine-to-machine communication has become a mundane feature of everyday life. From the earliest stirrings of the Internet Age, moreover, digital piracy has upended the view that "information"—in the form of songs, movies, books, or code—could remain contained. Put up a paywall here, and the content will diffuse over there, all so much informational entropy that cannot be conserved.

On the other hand, enormous multinational corporations—some of the largest and most profitable in the world—now routinely disprove Wiener's contention that "information" cannot be stockpiled or monetized. Ironically, the "information" they trade in is closer to Shannon's definition than Wiener's, Shannon's mathematical proofs notwithstanding.

While Google Books may help circulate hundreds of thousands of works of literature for free, Google itself—like Facebook, Amazon, Twitter, and their many imitators—has commandeered a baser form of "information" and exploited it for extraordinary profit. Petabytes of Shannon-like information—a seemingly meaningless stream of clicks, "likes," and retweets, collected from virtually every person who has ever touched a networked computer—are sifted through proprietary "deep-learning" algorithms to micro-target everything from the advertisements we see to the news stories (fake or otherwise) we encounter while browsing the Web.

Back in the early 1950s, Wiener had proposed that researchers study the structures and limitations of ants—in contrast to humans—so that machines might one day achieve the "almost indefinite intellectual expansion" that people (rather than insects) can attain. He found solace in the notion that machines could come to dominate us only "in the last stages of increasing entropy," when "the statistical differences among individuals are nil." Today's data-mining algorithms turn Wiener's approach on its head. They produce profit by exploiting our reptilian brains rather than imitating our cerebral cortexes, harvesting information from all our late-night, blog-addled, pleasure-seeking clickstreams—leveraging precisely the tiny, residual "statistical differences among individuals."

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[32] Matthew Arnold, *Culture and Anarchy,* Jane Garnett, ed. (Oxford, U.K.: Oxford University Press, 2006).

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To be sure, some recent achievements in artificial intelligence have been remarkably impressive. Computers can now produce visual artworks and musical compositions akin to those of recognized masters, creating just the sort of "information" that Wiener most prized. But by far the largest impact on society to date has come from the collection and manipulation of Shannon-like information, which has reshaped our shopping habits, political participation, personal relationships, expectations of privacy, and more.

What might "deep learning" evolve into, if the fundamental currency becomes "information" as Wiener defined it? How might the field shift if re-animated by Wiener's deep moral convictions, informed as they were by his prescient concerns about rampant militarism, runaway corporate profit-seeking, the self-limiting features of secrecy, and the reduction of human expression to interchangeable commodities? Perhaps "deep learning" might then become the cultivation of meaningful information rather than the relentless pursuit of potent, if meaningless, bits.

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In the aforementioned Connecticut discussion on The Human Use of Human Beings, **Neil Gershenfeld** *provided some fresh air, of a kind, by professing that he hated the book, which remark was met by universal laughter—as was his observation that computer science was one the worst things to happen to computers, or science. His overall contention was that Wiener missed the implications of the digital revolution that was happening around him—although some would say this charge can't be leveled at someone on the ground floor and lacking clairvoyance.*

"The tail wagging the dog of my life," he told us, "has been Fab Labs and the maker movement, and [when] Wiener talks about the threat of automation he misses the inverse, which is that access to the means for automation can empower people, and in Fab Labs, the corner I've been involved in, that's an exponential."

In 2003, I visited Neil at MIT, where he runs the Center for Bits and Atoms. Hours later, I emerged from what had been an exuberant display of very weird stuff. He showed me the work of one student in his popular rapid-prototyping class ("How to Make Almost Anything"), a sculptor with no engineering background, who had made a portable personal space for screaming that saves up your screams and plays them back later. Another student in the class had made a Web browser that lets parrots navigate the Net. Neil himself was doing fundamental research on the roadmap to that sci-fi staple, a "universal replicator." It was a visit that took me a couple of years to get my head around.

Neil manages a global network of Fab Labs—small-scale manufacturing systems, enabled by digital technologies, which give people the wherewithal to build whatever they'd like. As guru of the maker movement, which merges digital communication and computation with fabrication, he sometimes feels outside the current heated debate on AI safety. "My ability to do research rests on tools that augment my capabilities," he says. "Asking whether or not they are intelligent is as fruitful as asking how I know I exist—amusing philosophically, but not testable empirically." What interests him is "how bits and atoms relate—the boundary between digital and physical. Scientifically, it's the most exciting thing I know."

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SCALING
Neil Gershenfeld

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Discussions about artificial intelligence have been oddly ahistorical. They could better be described as manic-depressive; depending on how you count, we're now in the fifth boom-bust cycle. Those swings mask the continuity in the underlying progress and the implications for where it's headed.

The cycles have come in roughly decade-long waves. First there were mainframes, which by their very existence were going to automate away work. That ran into the reality that it was hard to write programs to do tasks that were simple for people to do. Then came expert systems, which were going to codify and then replace the knowledge of experts. These ran into difficulty in assembling that knowledge and reasoning about cases not already covered. Perceptrons sought to get around these problems by modeling how the brain learns, but they were unable to do much of anything. Multilayer perceptrons could handle test problems that had tripped up those simpler networks, but their demonstrations did poorly on unstructured, real-world problems. We're now in the deep-learning era, which is delivering on many of the early AI promises but in a way that's considered hard to understand, with consequences ranging from intellectual to existential threats.

Each of these stages was heralded as a revolutionary advance over the limitations of its predecessors, yet all effectively do the same thing: They make inferences from observations. How these approaches relate can be understood by how they scale—that is, how their performance depends on the difficulty of the problem they're addressing. Both a light switch and a self-driving car must determine their operator's intentions, but the former has just two options to choose from, whereas the latter has many more. The AI-boom phases have started with promising examples in limited domains; the bust phases came with the failure of those demonstrations to handle the complexity of less-structured, practical problems.

Less apparent is the steady progress we've made in mastering scaling. This progress rests on the technological distinction between linear and exponential functions—a distinction that was becoming evident at the dawn of AI but with implications for AI that weren't appreciated until many years later.

In one of the founding documents of the study of intelligent machines, *The Human Use of Human Beings*, Norbert Wiener does a remarkable job of identifying many of the most significant trends to arise since he wrote it, along with noting the people responsible for them and then consistently failing to recognize why these people's work proved to be so important. Wiener is credited with creating the field of cybernetics; I've never understood what that is, but what's missing from the book is at the heart of how AI has progressed. This history matters because of the echoes of it that persist to this day.

Claude Shannon makes a cameo appearance in the book, in the context of his thoughts about the prospects for a chess-playing computer. Shannon was doing

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something much more significant than speculating at the time: He was laying the foundations for the digital revolution. As a graduate student at MIT, he worked for Vannevar Bush on the Differential Analyzer. This was one of the last great analog computers, a room full of gears and shafts. Shannon's frustration with the difficulty of solving problems this way led him in 1937 to write what might be the best master's thesis ever. In it, he showed how electrical circuits could be designed to evaluate arbitrary logical expressions, introducing the basis for universal digital logic.

After MIT, Shannon studied communications at Bell Labs. Analog telephone calls degraded with distance; the farther they traveled, the worse they sounded. Rather than continue to improve them incrementally, Shannon showed in 1948 that by communicating with symbols rather than continuous quantities, the behavior is very different. Converting speech waveforms to the binary values of 1 and 0 is an example, but many other sets of symbols can be (and are) used in digital communications. What matters is not the particular symbols but rather the ability to detect and correct errors. Shannon found that if the noise is above a threshold (which depends on the system design), then there are certain to be errors. But if the noise is below a threshold, then a linear increase in the physical resources representing the symbol results in an exponential decrease in the likelihood of making an error in correctly receiving the symbol. This relationship was the first of what we'd now call a threshold theorem.

Such scaling falls off so quickly that the probability of an error can be so small as to effectively never happen. Each symbol sent multiplies rather than adds to the certainty, so that the probability of a mistake can go from 0.1 to 0.01 to 0.001, and so forth. This exponential decrease in communication errors made possible an exponential increase in the capacity of communication networks. And that eventually solved the problem of where the knowledge in an AI system came from.

For many years, the fastest way to speed up a computation was to do nothing—just wait for computers to get faster. In the same way, there were years of AI projects that aimed to accumulate everyday knowledge by laboriously entering pieces of information. That didn't scale; it could progress only as fast as the number of people doing the entering. But when phone calls, newspaper stories, and mail messages all moved onto the Internet, everyone doing any of those things became a data generator. The result was an exponential rather than a linear rate of knowledge accumulation.

John von Neumann also has a cameo in *The Human Use of Human Beings*, for game theory. What Wiener missed here was von Neumann's seminal role in digitizing computation. Whereas analog communication degraded with distance, analog computing (like the Differential Analyzer) degraded with time, accumulating errors as it progressed. Von Neumann presented in 1952 a result corresponding to Shannon's for computation (they had met at the Institute for Advanced Study, in Princeton), showing that it was possible to compute reliably with an unreliable computing device by using symbols rather than continuous quantities. This was, again, a scaling argument, with a linear increase in the physical resources representing the symbol resulting in an exponential reduction in the error rate as long as the noise was below a threshold. That's what makes it possible to have a billion transistors in a computer chip, with the last one as useful as the first one. This relationship led to an exponential increase in computing performance, which solved a second problem in AI: how to process exponentially increasing amounts of data.

The third problem that scaling solved for AI was coming up with the rules for

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reasoning without having to hire a programmer for each problem. Wiener recognized the role of feedback in machine learning, but he missed the key role of representation. It's not possible to store all possible images in a self-driving car, or all possible sounds in a conversational computer; they have to be able to generalize from experience. The "deep" part of deep learning refers not to the (hoped-for) depth of insight but to the depth of the mathematical network layers used to make predictions. It turned out that a linear increase in network complexity led to an exponential increase in the expressive power of the network.

If you lose your keys in a room, you can search for them. If you're not sure which room they're in, you have to search all the rooms in a building. If you're not sure which building they're in, you have to search all the rooms in all the buildings in a city. If you're not sure which city they're in, you have to search all the rooms in all the buildings in all the cities. In AI, finding the keys corresponds to things like a car safely following the road, or a computer correctly interpreting a spoken command, and the rooms and buildings and cities correspond to all of the options that have to be considered. This is called the curse of dimensionality.

The solution to the curse of dimensionality came in using information about the problem to constrain the search. The search algorithms themselves are not new. But when applied to a deep-learning network, they adaptively build up representations of where to search. The price of this is that it's no longer possible to exactly solve for the best answer to a problem, but typically all that's needed is an answer that's good enough.

Taken together, it shouldn't be surprising that these scaling laws have allowed machines to become effectively as capable as the corresponding stages of biological complexity. Neural networks started out with a goal of modeling how the brain works. That goal was abandoned as they evolved into mathematical abstractions unrelated to how neurons actually function. But now there's a kind of convergence that can be thought of as forward- rather than reverse-engineering biology, as the results of deep learning echo brain layers and regions.

One of the most difficult research projects I've managed paired what we'd now call data scientists with AI pioneers. It was a miserable experience in moving goalposts. As the former progressed in solving long-standing problems posed by the latter, this was deemed to not count because it wasn't accompanied by corresponding leaps in understanding the solutions. What's the value of a chess-playing computer if you can't explain how it plays chess?

The answer of course is that it can play chess. There is interesting emerging research that is applying AI to AI—that is, training networks to explain how they operate. But both brains and computer chips are hard to understand by watching their inner workings; they're easily interpreted only by observing their external interfaces. We come to trust (or not) brains and computer chips alike based on experience that tests them rather than on explanations for how they work.

Many branches of engineering are making a transition from what's called imperative to declarative or generative design. This means that instead of explicitly designing a system with tools like CAD files, circuit schematics, and computer code, you describe what you want the system to do and then an automated search is done for designs that satisfy your goals and restrictions. This approach becomes necessary as design complexity exceeds what can be understood by a human designer. While that

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might sound like a risk, human understanding comes with its own limits; engineering design is littered with what appeared to be good insights that have had bad consequences. Declarative design rests on all the advances in AI, plus the improving fidelity of simulations to virtually test designs.

The mother of all design problems is the one that resulted in us. The way we're designed resides in one of the oldest and most conserved parts of the genome, called the Hox genes. These are genes that regulate genes, in what are called developmental programs. Nothing in your genome stores the design of your body; your genome stores, rather, a series of steps to follow that results in your body. This is an exact parallel to how search is done in AI. There are too many possible body plans to search over, and most modifications would be either inconsequential or fatal. The Hox genes are a representation of a productive place for evolutionary search. It's a kind of natural intelligence at the molecular level.

AI has a mind-body problem, in that it has no body. Most work on AI is done in the cloud, running on virtual machines in computer centers where data are funneled. Our own intelligence is the result of a search algorithm (evolution) that was able to change our physical form as well as our programming—those are inextricably linked. If the history of AI can be understood as the working of scaling laws rather than a succession of fashions, then its future can be seen in the same way. What's now being digitized, after communication and computation, is fabrication, bringing the programmability of bits to the world of atoms. By digitizing not just designs but the construction of materials, the same lessons that von Neumann and Shannon taught us apply to exponentially increasing fabricational complexity.

I've defined digital materials to be those constructed from a discrete set of parts reversibly joined with a discrete set of relative positions and orientations. These attributes allow the global geometry to be determined from local constraints, assembly errors to be detected and corrected, heterogeneous materials to be joined, and structures to be disassembled rather than disposed of when they're no longer needed. The amino acids that are the foundation of life and the Lego bricks that are the foundation of play share these properties.

What's interesting about amino acids is that they're not interesting. They have attributes that are typical but not unusual, such as attracting or repelling water. But just twenty types of them are enough to make you. In the same way, twenty or so types of digital-material part types—conducting, insulating, rigid, flexible, magnetic, etc.—are enough to assemble the range of functions that go into making modern technologies like robots and computers.

The connection between computation and fabrication was foreshadowed by the very pioneers whose work the edifice of computing is based on. Wiener hinted at this by linking material transportation with message transportation. John von Neumann is credited with modern computer architecture, something he actually wrote very little about; the final thing he studied, and wrote about beautifully and at length, was self-reproducing systems. As an abstraction of life, he modeled a machine that can communicate a computation that constructs itself. And the final thing Alan Turing, who is credited with the theoretical framework for computer science, studied was how the instructions in genes can give rise to physical forms. These questions address a topic absent from a typical computer-science education: the physical configuration of a

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computation.

Von Neumann and Turing posed their questions as theoretical studies, because it was beyond the technology of their day to realize them. But with the convergence of communication and computation with fabrication, these investigations are now becoming accessible experimentally. Making an assembler that can assemble itself from the parts that it's assembling is a focus of my lab, along with collaborations to develop synthetic cells.

The prospect of physically self-reproducing automata is potentially much scarier than fears of out-of-control AI, because it moves the intelligence out here to where we live. It could be a roadmap leading to Terminator's Skynet robotic overlords. But it's also a more hopeful prospect, because an ability to program atoms as well as bits enables designs to be shared globally while locally producing things like energy, food, and shelter—all of these are emerging as exciting early applications of digital fabrication. Wiener worried about the future of work, but he didn't question implicit assumptions about the nature of work which are challenged when consumption can be replaced by creation.

History suggests that neither utopian nor dystopian scenarios prevail; we generally end up muddling along somewhere in between. But history also suggests that we don't have to wait on history. Gordon Moore in 1965 was able to use five years of the doubling of the specifications of integrated circuits to project what turned out to be fifty years of exponential improvements in digital technologies. We've spent many of those years responding to, rather than anticipating, its implications. We have more data available now than Gordon Moore did to project fifty years of doubling the performance of digital fabrication. With the benefit of hindsight, it should be possible to avoid the excesses of digital computing and communications this time around, and, from the outset, address issues like access and literacy.

If the maker movement is the harbinger of a third digital revolution, the success of AI in meeting many of its own early goals can be seen as the crowning achievement of the first two digital revolutions. Although machine making and machine thinking might appear to be unrelated trends, they lie in each other's futures. The same scaling trends that have made AI possible suggest that the current mania is a phase that will pass, to be followed by something even more significant: the merging of artificial and natural intelligence.

It was an advance for atoms to form molecules, molecules to form organelles, organelles to form cells, cells to form organs, organs to form organisms, organisms to form families, families to form societies, and societies to form civilizations. This grand evolutionary loop can now be closed, with atoms arranging bits arranging atoms.

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While **Danny Hillis** *was an undergraduate at MIT, he built a computer out of Tinkertoys. It has around 10,000 wooden parts, plays tic-tac-toe, and never loses; it's now in the Computer History Museum, in Mountain View, California.*

As a graduate student at the MIT Computer Science and Artificial Intelligence Laboratory in the early 1980s, Danny designed a massively parallel computer with 64,000 processors. He named it the Connection Machine and founded what may have been the first AI company—Thinking Machines Corporation—to produce and market it. This was despite a lunch he had with Richard Feynman, at which the celebrated physicist remarked, "That is positively the dopiest idea I ever heard." Maybe "despite" is the wrong word, since Feynman had a well-known predilection for playing with dopey ideas. In the event, he showed up on the day the company was incorporated and stayed on, for summer jobs and special assignments, to make invaluable contributions to its work.

Danny has since established a number of technology companies, of which the latest is Applied Invention, which partners with commercial enterprises to develop technological solutions to their most intractable problems. He holds hundreds of U.S. patents, covering parallel computers, touch interfaces, disk arrays, forgery prevention methods, and a slew of electronic and mechanical devices. His imagination is apparently boundless, and here he sketches some possible scenarios that will result from our pursuit of a better and better AI.

"Our thinking machines are more than metaphors," he says. "The question is not, 'Will they be powerful enough to hurt us?' (they will), or whether they will always act in our best interests (they won't), but whether over the long term they can help us find our way—where we come out on the Panacea/Apocalypse continuum."

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THE FIRST MACHINE INTELLIGENCES

W. Daniel Hillis

***W. Daniel "Danny" Hillis** is an inventor, entrepreneur, and computer scientist, Judge Widney Professor of Engineering and Medicine at USC, and author of* The Pattern on the Stone: The Simple Ideas That Make Computers Work.

> I have spoken of machines, but not only of machines having brains of brass and thews of iron. When human atoms are knit into an organization in which they are used, not in their full right as responsible human beings, but as cogs and levers and rods, it matters little that their raw material is flesh and blood. *What is used as an element in a machine, is in fact an element in the machine.* Whether we entrust our decisions to machines of metal, or to those machines of flesh and blood which are bureaus and vast laboratories and armies and corporations, we shall never receive the right answers to our questions unless we ask the right questions.... The hour is very late, and the choice of good and evil knocks at our door.
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> —Norbert Wiener, *The Human Use of Human Beings*

Norbert Wiener was ahead of his time in recognizing the potential danger of emergent intelligent machines. I believe he was even further ahead in recognizing that the first artificial intelligences had already begun to emerge. He was correct in identifying the corporations and bureaus that he called "machines of flesh and blood" as the first intelligent machines. He anticipated the dangers of creating artificial superintelligences with goals not necessarily aligned with our own.

What is now clear, whether or not it was apparent to Wiener, is that these organizational superintelligences are not just made of humans, they are hybrids of humans and the information technologies that allow them to coordinate. Even in Wiener's time, the "bureaus and vast laboratories and armies and corporations" could not operate without telephones, telegraphs, radios, and tabulating machines. Today they could not operate without networks of computers, databases, and decision support systems. These hybrid intelligences are technologically augmented networks of humans. These artificial intelligences have superhuman powers. They can know more than individual humans; they can sense more; they can make more complicated analyses and more complex plans. They can have vastly more resources and power than any single individual.

Although we do not always perceive it, hybrid superintelligences such as nation states and corporations have their own emergent goals. Although they are built by and for humans, they often act like independent intelligent entities, and their actions are not always aligned to the interests of the people who created them. The state is not always for the citizen, nor the company for the shareholder. Nor do not-for-profits, religious orders, or political parties always act in furtherance of their founding principles. Intuitively, we recognize that their actions are guided by internal goals, which is why we personify them, both legally and in our habits of thought. When talking about "what China wants," or "what General Motors is trying to do," we are not speaking in metaphors. These organizations act as intelligences that perceive, decide, and act. Like the goals of individual humans, the goals of organizations are complex and often self-contradictory, but they are true goals in the sense that they direct action. Those goals

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depend somewhat on the goals of the people within the organization, but they are not identical.

Any American knows how loose the tie is between the actions of the U.S. government and the diverse and often contradictory aims of its citizens. That is also true of corporations. For-profit corporations nominally serve multiple constituencies, including shareholders, senior executives, employees, and customers. These corporations differ in how they balance their loyalties and often behave in ways that serve none of their constituents. The "neurons" that carry their corporate thought are not just the human employees or the technologies that connect them; they are also coded into the policies, incentive structures, culture, and procedural habits of the corporation. The emergent corporate goals do not always reflect the values of the people who implement them. For instance, an oil company led and staffed by people who care about the environment may have incentive structures or policies that cause it to compromise environmental safety for the sake of corporate earnings. The components' good intentions are not a guarantee of the emergent system's good behavior.

Governments and corporations, both built partly of humans, are naturally motivated to at least appear to share the goals of the humans they depend upon. They could not function without the people, so they need to keep them cooperative. When such organizations appear to behave altruistically, this is often part of their motive. I once complimented the CEO of a large corporation on the contribution his company made toward a humanitarian relief effort. The CEO responded, without a trace of irony, "Yes. We have decided to do more things like that to make our brand more likeable." Individuals who compose a hybrid superintelligence may occasionally exert a "humanizing" influence—for example, an employee may break company policies to accommodate the needs of another human. The employee may act out of true human empathy, but we should not attribute any such empathy to the superintelligence itself. These hybrid machines have goals, and their citizens/customers/employees are some of the resources they use to accomplish them.

We are close to being able to build superintelligences out of pure information technology, without human components. This is what people normally refer to as "artificial intelligence," or AI. It is reasonable to ask what the attitudes of the hypothetical machine superintelligences will be toward humans. Will they, too, see humans as useful resources and a good relationship with us as worth preserving? Will they be constructed to have goals that are aligned with our own? Will a superintelligence even see these questions as important? What are the "right questions" that we should be asking? I believe that one of the most important is this: What relationship will various superintelligences have to one another?

It is interesting to consider how the hybrid superintelligences currently deal with conflicts among themselves. Today, much of the ultimate power rests in the nation states, which claim authority over a patch of ground. Whether they are optimized to act in the interests of their citizens or those of a despotic ruler, nation states assert priority over other intelligences' desires or goals within their geographic dominion. They claim a monopoly on the use of force and recognize only other nation states as peers. They are willing, if necessary, to demand great sacrifices of their citizens to enforce their authority, even to the point of sacrificing their citizens' lives.

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This geographical division of authority made logical sense when most of the actors were humans who spent their lives within a single nation state, but now that the actors of importance include geographically distributed hybrid intelligences such as multinational corporations, that logic is less obvious. Today we live in a complex transitional period, when distributed superintelligences still largely rely on the nation states to settle the arguments arising among them. Often, those arguments are resolved differently in different jurisdictions. It is becoming more difficult even to assign individual humans to nation states: International travelers living and working outside their native country, refugees, and immigrants (documented and not) are still dealt with as awkward exceptions. Superintelligences built purely of information technology will prove even more awkward for the territorial system of authority, since there is no reason why they need to be tied to physical resources in a single country—or even to any particular physical resources at all. An artificial intelligence might well exist "in the cloud" rather than at any physical location.

I can imagine at least four scenarios for how machine superintelligences will relate to hybrid superintelligences.

In one obvious scenario, multiple machine intelligences will ultimately be controlled by, and allied with, individual nation states. In this state/AI scenario, one can envision American and Chinese super-AIs wrestling each other for resources on behalf of their state. In some sense, these AIs would be citizens of their nation state in the way that many commercial corporations often act as "corporate citizens" today. In this scenario, the host nation states would presumably give the machine superintelligences the resources they needed to work for the state's advantage. Or, to the degree that the superintelligences can influence their state governments, they will presumably do so to enhance their own power, for instance by garnering a larger share of the state's resources. Nation states' AIs might not want competing AIs to grow up within their jurisdiction. In this scenario, the superintelligences become an extension of the state, and vice versa.

The state/AI scenario seems plausible, but it is not our current course. Our most powerful and rapidly improving artificial intelligences are controlled by for-profit corporations. This is the corporate/AI scenario, in which the balance of power between nation states and corporations becomes inverted. Today, the most powerful and intelligent collections of machines are probably owned by Google, but companies like Amazon, Baidu, Microsoft, Facebook, Apple, and IBM may not be far behind. These companies all see a business imperative to build artificial intelligences of their own. It is easy to imagine a future in which corporations independently build their own machine intelligences, protected within firewalls preventing the machines from taking advantage of one another's knowledge. These machines will be designed to have goals aligned with those of the corporation. If this alignment is effective, nation states may continue to lag behind in developing their own artificial-intelligence capability and instead depend on their "corporate citizens" to do it for them. To the extent that corporations successfully control the goals, they will become more powerful and autonomous than nation states.

Another scenario, perhaps the one people fear the most, is that artificial intelligences will not be aligned with either humans or hybrid superintelligences but will act solely in their own interest. They might even merge into a single machine superintelligence, since there may be no technical requirement for machine intelligences to maintain distinct identities. The attitude of a self-interested super-AI toward hybrid

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superintelligences is likely to be competitive. Humans might be seen as minor annoyances, like ants at a picnic, but hybrid superintelligences—like corporations, organized religions, and nation states—could be existential threats. Like hybrid superintelligences, AIs might see humans mostly as useful tools to accomplish their goals, as pawns in their competition with the other superintelligences. Or we might simply be irrelevant. It is not impossible that a machine intelligence has already emerged and we simply do not recognize it as such. It may not wish to be noticed, or it may be so alien to us that we are incapable of perceiving it. This makes the self-interested AI scenario the most difficult to imagine. I believe the easy-to-imagine versions, like the humanoid intelligent robots of science fiction, are the least likely. Our most complex machines, like the Internet, have already grown beyond the detailed understanding of a single human, and their emergent behaviors may be well beyond our ken.

The final scenario is that machine intelligences will not be allied with one another but instead will work to further the goals of humanity as a whole. In this optimistic scenario, AI could help us restore the balance of power between the individual and the corporation, between the citizen and the state. It could help us solve the problems that have been created by hybrid superintelligences that subvert the goals of humans. In this scenario, AIs will empower us by giving us access to processing capacity and knowledge currently available only to corporations and states. In effect, they could become extensions of our own individual intelligences, in furtherance of our human goals. They could make our weak individual intelligences strong. This prospect is both exciting and plausible. It is plausible because we have some choice in what we build, and we have a history of using technology to expand and augment our human capacities. As airplanes have given us wings and engines have given us muscles to move mountains, so our network of computers may amplify and extend our minds. We may not fully understand or control our destiny, but we have a chance to bend it in the direction of our values. The future is not something that will happen to us; it is something that we will build.

Why Wiener Saw What Others Missed

> There is in electrical engineering a split which is known in Germany as the split between the technique of strong currents and the technique of weak currents, and which we know as the distinction between power and communication engineering. It is this split which separates the age just past from that in which we are now living.
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> —Norbert Wiener, *Cybernetics, or Control and Communication in the Animal and the Machine*

Cybernetics is the study of the how the weak can control the strong. Consider the defining metaphor of the field: the helmsman guiding a ship with a tiller. The helmsman's goal is to control the heading of the ship, to keep it on the right course. The information, the message that is sent to the helmsman, comes from the compass or the stars, and the helmsman closes the feedback loop by sending the steering messages through the gentle force of his hand on the tiller. In this picture, we see the ship tossing in powerful wind and waves in the real world, controlled by the communication system of messages in the world of information.

Yet the distinction between "real" and "information" is mostly a difference in perspective. The signals that carry messages, like the light of the stars and pressure of the

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hand on the tiller, exist in a world of energy and forces, as does the helmsman. The weak forces that control the rudder are as real and physical as the strong forces that toss the ship. If we shift our cybernetics perspective from the ship to the helmsman, the pressures on the rudder become a strong force of muscles controlled by the weak signals in the mind of the helmsman. These messages in the helmsman's mind are amplified into a physical force strong enough to steer the ship. Or instead, we can zoom out and take a large cybernetics perspective. We might see the ship itself as part of a vast trade network, part of a feedback loop that regulates the price of commodities through the flow of goods. In this perspective, the tiny ship is merely a messenger. So, the distinction between the physical world and the information world is a way to describe the relationship between the weak and the strong.

Wiener chose to view the world from the vantage point and scale of the individual human. As a cyberneticist, he took the perspective of the weak protagonist embedded within a strong system, trying to make the best of limited powers. He incorporated this perspective in his very definition of information. "Information," he said, "is a name for the content of what is exchanged with the outer world as we adjust to it, and make our adjustment felt upon it." In his words, information is what we use to "live effectively within that environment."[33] For Wiener, information is a way for the weak to effectively cope with the strong. This viewpoint is also reflected in Gregory Bateson's definition of information as "a difference that makes a difference," by which he meant the small difference that makes a big difference.

The goal of cybernetics was to create a tiny model of the system using "weak currents" to amplify and control "strong currents" of the real world. The central insight was that a control problem could be solved by building an analogous system in the information space of messages and then amplifying solutions into the larger world of reality. Inherent in the motion of a control system is the concept of amplification, which makes the small big and the weak strong. Amplification allows the difference that makes a difference to make a difference.

In this way of looking at the world, a control system needed to be as complex as the system it controlled. Cyberneticist W. Ross Ashby proved that this was true in a precise mathematical sense, in what is now called Ashby's Law of Requisite Variety, or sometimes the First Law of Cybernetics. The law tells us that to control a system completely, the controller must be as complex as the controlled. Thus cyberneticists tended to see control systems as a kind of analog of the systems they governed, like the homunculus—the hypothetical little person inside the brain who controls the actual person.

This notion of analogous structure is sometimes confused with the notion of analog encoding of messages, but the two are logically distinct. Norbert Wiener was much impressed with Vannevar Bush's Digital Differential Analyzer, which could be reconfigured to match the structure of whatever problem it was given to solve but used digital signal encoding. Signals could be simplified to openly represent the relevant distinctions, allowing them to be more accurately communicated and stored. In digital signals, one needed only to preserve the difference in signals that made a difference. It is this distinction and signal coding that we commonly use to distinguish "analog" versus "digital." Digital signal encoding was entirely compatible with cybernetic thinking—in

[33] *The Human Use of Human Beings* (Boston: Houghton Mifflin, 1954), p. 17-18.

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fact, enabling to it. What was constraining to cybernetics was the presumption of an analogy of structure between the controller and the controlled. By the 1930s, Kurt Gödel, Alonzo Church, and Alan Turing had all described universal systems of computation, in which the computation required no structural analogy to functions that were computed. These universal computers could also compute the functions of control.

The analogy of structure between the controller and the controlled was central to the cybernetic perspective. Just as digital coding collapses the space of possible messages into a simplified version that represents only the difference that makes a difference, so the control system collapses the state space of a controlled system into a simplified model that reflects only the goals of the controller. Ashby's Law does not imply that every controller must model every state of the system but only those states that matter for advancing the controller's goals. Thus, in cybernetics, the goal of the controller becomes the perspective from which the world is viewed.

Norbert Wiener adopted the perspective of the individual human relating to vast organizations and trying to "live effectively within that environment." He took the perspective of the weak trying to influence the strong. Perhaps this is why he was able to notice the emergent goals of the "machines of flesh and blood" and anticipate some of the human challenges posed by these new intelligences, hybrid machine intelligences with goals of their own.

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Venki Ramakrishnan *is a Nobel Prize-winning biologist whose many scientific contributions include his work on the atomic structure of the ribosome—in effect, a huge molecular machine that reads our genes and makes proteins. His work would have been impossible without powerful computers. The Internet made his own work a lot easier and, he notes, acted as a leveler internationally: "When I grew up in India, if you wanted to get a book, it would show up six months or a year after it had already come out in the West. . . . Journals would arrive by surface mail a few months later. I didn't have to deal with it, because I left India when I was nineteen, but I know Indian scientists had to deal with it. Today they have access to information at the click of a button. More important, they have access to lectures. They can listen to Richard Feynman. That would have been a dream of mine when I was growing up. They can just watch Richard Feynman on the Web. That's a big leveling in the field." And yet. . . "Along with the benefits [of the Web], there is now a huge amount of noise. You have all of these people spouting pseudoscientific jargon and pushing their own ideas as if they were science."*

As president of the Royal Society, Venki worries, too, about the broader issue of trust: public trust in evidence-based scientific findings, but also trust among scientists, bolstered by rigorous checking of one another's conclusions—trust that is in danger of eroding because of the "black box" character of deep-learning computers. "This [erosion] is going to happen more and more, as data sets get bigger, as we have genome-wide studies, population studies, and all sorts of things," he says. "How do we, as a science community, grapple with this and communicate to the public a sense of what science is about, what is reliable in science, what is uncertain in science, and what is just plain wrong in science?"

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WILL COMPUTERS BECOME OUR OVERLORDS?

Venki Ramakrishnan

Venki Ramakrishnan *is a scientist at the Medical Research Council Laboratory of Molecular Biology, Cambridge University; recipient of the Nobel Prize in Chemistry (2009); current president of the Royal Society; and the author of* Gene Machine: The Race to Discover the Secrets of the Ribosome.

A former colleague of mine, Gérard Bricogne, used to joke that carbon-based intelligence was simply a catalyst for the evolution of silicon-based intelligence. For quite a long time, both Hollywood movies and scientific Jeremiahs have been predicting our eventual capitulation to our computer overlords. We all await the singularity, which always seems to be just over the horizon.

In a sense, computers have already taken over, facilitating virtually every aspect of our lives—from banking, travel, and utilities to the most intimate personal communication. I can see and talk to my grandson in New York *for free*. I remember when I first saw the 1968 movie *2001: A Space Odyssey*, the audience laughed at the absurdly cheap cost of a picturephone call from space: $1.70, at a time when a long-distance call within the U.S. was $3 per minute.

However, the convenience and power of computers is also something of a Faustian bargain, for it comes with a loss of control. Computers prevent us from doing things we want. Try getting on a flight if you arrive at the airport and the airline computer systems are down, as happened not so long ago to British Airways at Heathrow. The planes, pilots, and passengers were all there; even the air-traffic controls were working. But no flights for that airline were allowed to take off. Computers also make us do things we *don't* want—by generating mailing lists and print labels to send us all millions of pieces of unwanted mail, which we humans have to sort, deliver, and dispose of.

But you ain't seen nothing yet. In the past, we programmed computers using algorithms we understood at least in principle. So when machines did amazing things like beating world chess champion Garry Kasparov, we could say that the victorious programs were designed with algorithms based on our own understanding—using, in this instance, the experience and advice of top grandmasters. Machines were simply faster at doing brute-force calculations, had prodigious amounts of memory, and were not prone to errors. One article described Deep Blue's victory not as that of a computer, which was just a dumb machine, but as the victory of hundreds of programmers over Kasparov, a single individual.

That way of programming is changing dramatically. After a long hiatus, the power of machine learning has taken off. Much of the change came when programmers, rather than trying to anticipate and code for every possible contingency, allowed computers to train themselves on data, using deep neural networks based on models of how our own brains learn. They use probabilistic methods to "learn" from large quantities of data; computers can recognize patterns and come up with conclusions on their own. A particularly powerful method is called reinforcement learning, by which the computer learns, without prior input, which variables are important and how much to

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weight them to reach a certain goal. This method in some sense mimics how we learn as children. The results from these new approaches are amazing.

Such a deep-learning program was used to teach a computer to play Go, a game that only a few years ago was thought to be beyond the reach of AI because it was so hard to calculate how well you were doing. It seemed that top Go players relied a great deal on intuition and a feel for position, so proficiency was thought to require a particularly human kind of intelligence. But the AlphaGo program produced by DeepMind, after being trained on thousands of high-level Go games played by humans and then millions of games with itself, was able to beat the top human players in short order. Even more amazingly, the related AlphaGo Zero program, which learned from scratch by playing itself, was stronger than the version trained initially on human games! It was as though the humans had been preventing the computer from reaching its true potential. The same method has recently been generalized: Starting from scratch, within just twenty-four hours, an equivalent AlphaZero chess program was able to beat today's top "conventional" chess programs, which in turn have beaten the best humans.

Progress has not been restricted to games. Computers are significantly better at image and voice recognition and speech synthesis than they used to be. They can detect tumors in radiographs earlier than most humans. Medical diagnostics and personalized medicine will improve substantially. Transportation by self-driving cars will keep us all safer, on average. My grandson may never have to acquire a driver's license, because driving a car will be like riding a horse today—a hobby for the few. Dangerous activities, such as mining, and tedious repetitive work will be done by computers. Governments will offer better targeted, more personalized and efficient public services. AI could revolutionize education by analyzing an individual pupil's needs and enabling customized teaching, so that each student can advance at an optimal rate.

Along with these huge benefits, of course, will come alarming risks. With the vast amounts of personal data, computers will learn more about us than we may know about ourselves; the question of who owns data about us will be paramount. Moreover, data-based decisions will undoubtedly reflect social biases: Even an allegedly neutral intelligent system designed to predict loan risks, say, may conclude that mere membership in a particular minority group makes you more likely to default on a loan. While this is an obvious example that we could correct, the real danger is that we are not always aware of biases in the data and may simply perpetuate them.

Machine learning may also perpetuate our own biases. When Netflix or Amazon tries to tell you what you might want to watch or buy, this is an application of machine learning. Currently such suggestions are sometimes laughable, but with time and more data they will get increasingly accurate, reinforcing our prejudices and likes and dislikes. Will we miss out on the random encounter that might persuade us to change our views by exposing us to new and conflicting ideas? Social media, given its influence on elections, is a particularly striking illustration of how the divide between people on different sides of the political spectrum can be accentuated.

We may have already reached the stage where most governments are powerless to resist the combined clout of a few powerful multinational companies that control us and our digital future. The fight between dominant companies today is really a fight for control over our data. They will use their enormous influence to prevent regulation of data, because their interests lie in unfettered control of it. Moreover, they have the

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financial resources to hire the most talented workers in the field, enhancing their power even further. We have been giving away valuable data for the sake of freebies like Gmail and Facebook, but as the journalist and author John Lanchester has pointed out in the *London Review of Books*, if it is free, then you are the product. Their real customers are the ones who pay them for access to knowledge about us, so that they can persuade us to buy their products or otherwise influence us. One way around the monopolistic control of data is to split the ownership of data away from firms that use them. Individuals would instead own and control access to their personal data (a model that would encourage competition, since people would be free to move their data to a company that offered better services). Finally, abuse of data is not limited to corporations: In totalitarian states, or even nominally democratic ones, governments know things about their citizens that Orwell could not have imagined. The use they make of this information may not always be transparent or possible to counter.

The prospect of AI for military purposes is frightening. One can imagine intelligent systems being designed to act autonomously based on real-time data and able to act faster than the enemy, starting catastrophic wars. Such wars may not necessarily be conventional or even nuclear wars. Given how essential computer networks are to modern society, it is much more likely that AI wars will be fought in cyberspace. The consequences could be just as dire.

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Despite this loss of control, we continue to march inexorably into a world in which AI will be everywhere: Individuals won't be able to resist its convenience and power, and corporations and governments won't be able to resist its competitive advantages. But important questions arise about the future of work. Computers have been responsible for considerable losses in blue-collar jobs in the last few decades, but until recently many white-collar jobs—jobs that "only humans can do"—were thought to be safe. Suddenly that no longer appears to be true. Accountants, many legal and medical professionals, financial analysts and stockbrokers, travel agents—in fact, a large fraction of white-collar jobs—will disappear as a result of sophisticated machine-learning programs. We face a future in which factories churn out goods with very few employees and the movement of goods is largely automated, as are many services. What's left for humans to do?

In 1930—long before the advent of computers, let alone AI—John Maynard Keynes wrote, in an essay called "Economic Possibilities for our Grandchildren," that as a result of improvements in productivity, society could produce all its needs with a fifteen-hour work week. He also predicted, along with the growth of creative leisure, the end of money and wealth as a goal:

> We shall be able to afford to dare to assess the money-motive at its true value. The love of money as a possession—as distinguished from the love of money as a means to the enjoyments and realities of life—will be recognised for what it is, a somewhat disgusting morbidity, one of those semi-criminal, semi-pathological propensities which one hands over with a shudder to the specialists in mental disease.

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Sadly, Keynes's predictions did not come true. Although productivity did indeed increase, the system—possibly inherent in a market economy—did not result in humans working much shorter hours. Rather, what happened is what the anthropologist and anarchist David Graeber describes as the growth of "bullshit jobs."[34] While jobs that produce essentials like food, shelter, and goods have been largely automated away, we have seen an enormous expansion of sectors like corporate law, academic and health administration (as opposed to actual teaching, research, and the practice of medicine), "human resources," and public relations, not to mention new industries like financial services and telemarketing and ancillary industries in the so-called gig economy which serve those who are too busy doing all that additional work.

How will societies cope with technology's increasingly rapid destruction of entire professions and throwing large numbers of people out of work? Some argue that this concern is based on a false premise, because new jobs spring up that didn't exist before, but as Graeber points out, these new jobs won't necessarily be rewarding or fulfilling. During the first industrial revolution, it took almost a century before most people were better off. That revolution was possible only because the government of the time ruthlessly favored property rights over labor, and most people (and all women) did not have the vote. In today's democratic societies, it is not clear that the population will tolerate such a dramatic upheaval of society based on the promise that "eventually" things will get better.

Even that rosy vision will depend on a radical shake-up of education and lifelong learning. The Industrial Revolution did trigger enormous social change of this kind, including a shift to universal education. But it will not happen unless we make it happen: This is essentially about power, agency, and control. What's next for, say, the forty-year-old taxi driver or truck driver in an era of autonomous vehicles?

One idea that has been touted is that of a universal basic income, which will allow citizens to pursue their interests, retrain for new occupations, and generally be free to live a decent life. However, market economies, which are predicated on growing consumer demand over all else, may not tolerate this innovation. There is also a feeling among many that meaningful work is essential to human dignity and fulfillment. So another possibility is that the enormous wealth generated by increased productivity due to automation could be redistributed to jobs requiring human labor and creativity in fields such as the arts, music, social work, and other worthwhile pursuits. Ultimately, which jobs are rewarding or productive and which are "bullshit" is a matter of judgment and may vary from society to society, as well as over time.

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So far, I've focused on AI's practical consequences. As a scientist, what bothers me is our potential loss of understanding. We are now accumulating data at an incredible rate. In my own lab, an experiment generates over a terabyte of data a day. These data are massaged, analyzed, and reduced until there is an interpretable result. But in all of this data analysis, we believe we know what's happening. We know what the programs are

[34] https://strikemag.org/bullshit-jobs/

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doing because we designed the algorithms at their heart. So when our computers generate a result, we feel that we intellectually grasp it.

The new machine-learning programs are different. Having recognized patterns via deep neural networks, they come up with conclusions, and we have no idea exactly how. When they uncover relationships, we don't understand it in the same way as if we had deduced those relationships ourselves using an underlying theoretical framework. As data sets become larger, we won't be able to analyze them ourselves even with the help of computers; rather, we will rely entirely on computers to do the analysis for us. So if someone asks us how we know something, we will simply say it is because the machine analyzed the data and produced the conclusion.

One day a computer may well come up with an entirely new result—e.g., a mathematical theorem whose proof, or even whose statement, no human can understand. That is philosophically different from the way we have been doing science. Or at least thought we had; some might argue that we don't know how our own brains reach conclusions either, and that these new methods are a way of mimicking learning by the human brain. Nevertheless, I find this potential loss of understanding disturbing.

Despite the remarkable advances in computing, the hype about AGI—a general-intelligence machine that will think like a human and possibly develop consciousness—smacks of science fiction to me, partly because we don't understand the brain at that level of detail. Not only do we not understand what consciousness is, we don't even understand a relatively simple problem like how we remember a phone number. In just that one question, there are all sorts of things to consider. How do we know it is a number? How do we associate it with a person, a name, face, and other characteristics? Even such seemingly trivial questions involve everything from high-level cognition and memory to how a cell stores information and how neurons interact.

Moreover, that's just one task among many that the brain does effortlessly. Whereas machines will no doubt do ever more amazing things, they're unlikely to be a replacement for human thought and human creativity and vision. Eric Schmidt, former chairman of Google's parent company, said in a recent interview at the London Science Museum that even designing a robot that would clear the table, wash the dishes, and put them away was a huge challenge. The calculations involved in figuring out all the movements the body has to make to throw a ball accurately or do slalom skiing are prodigious. The brain can do all these and also do mathematics and music, and *invent* games like chess and Go, not just play them. We tend to underestimate the complexity and creativity of the human brain and how amazingly general it is.

If AI is to become more humanlike in its abilities, the machine-learning and neuroscience communities need to interact closely, something that is happening already. Some of today's greatest exponents of machine learning—such as Geoffrey Hinton, Zoubin Ghahramani, and Demis Hassabis—have backgrounds in cognitive neuroscience, and their success has been at least in part due to attempts to model brainlike behavior in their algorithms. At the same time, neurobiology has also flourished. All sorts of tools have been developed to watch which neurons are firing and genetically manipulate them and see what's happening in real time with inputs. Several countries have launched moon-shot neuroscience initiatives to see if we can crack the workings of the brain. Advances in AI and neuroscience seem to go hand in hand; each field can propel the other.

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Many evolutionary scientists, and such philosophers as Daniel Dennett, have pointed out that the human brain is the result of billions of years of evolution.[35] Human intelligence is not the special characteristic we think it is, but just another survival mechanism not unlike our digestive or immune systems, both of which are also amazingly complex. Intelligence evolved because it allowed us to make sense of the world around us, to plan ahead, and thus cope with all sorts of unexpected things in order to survive. However, as Descartes stated, we humans define our very existence by our ability to think. So it is not surprising that, in an anthropomorphic way, our fears about AI reflect this belief that our intelligence is what makes us special.

But if we step back and look at life on Earth, we see that we are far from the most resilient species. If we're going to be taken over at some point, it will be by some of Earth's oldest life-forms, like bacteria, which can live anywhere from Antarctica to deep-sea thermal vents hotter than boiling water, or in acid environments that would melt you and me. So when people ask where we're headed, we need to put the question in a broader context. I don't know what sort of future AI will bring: whether AI will make humans subservient or obsolete or will be a useful and welcome enhancement of our abilities which will enrich our lives. But I am reasonably certain that computers will never be the overlords of bacteria.

[35] See, for example, Dennett's *From Bacteria to Bach and Back: The Evolution of Minds* (New York: W. W. Norton, 2017).

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Alex "Sandy" Pentland, *an exponent of what he has termed "social physics," is interested in building powerful human-AI ecologies. He is concerned at the same time about the potential dangers of decision-making systems in which the data in effect take over and human creativity is relegated to the background.*

The advent of Big Data, he believes, has given us the opportunity to reinvent our civilization: "We can now begin to actually look at the details of social interaction and how those play out, and we're no longer limited to averages like market indices or election results. This is an astounding change. The ability to see the details of the market, of political revolutions, and to be able to predict and control them is definitely a case of Promethean fire—it could be used for good or for ill. Big Data brings us to interesting times."

At our group meeting in Washington, Connecticut, he confessed that reading Norbert Wiener on the concept of feedback "felt like reading my own thoughts."

"After Wiener, people discovered or focused on the fact that there are genuinely chaotic systems that are just not predictable," he said, "but if you look at human socioeconomic systems, there is a large percentage of variance you can account for and predict. . . . Today there is data from all sorts of digital devices, and from all of our transactions. The fact that everything is datafied means you can measure things in real time in most aspects of human life—and increasingly in every aspect of human life. The fact that we have interesting computers and machine-learning techniques means that you can build predictive models of human systems in ways you could never do before."

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THE HUMAN STRATEGY
Alex "Sandy" Pentland

Alex "Sandy" Pentland *is Toshiba Professor and professor of media arts and sciences, MIT; director of the Human Dynamics and Connection Science labs and the Media Lab Entrepreneurship Program, and the author of* Social Physics.

In the last half-century, the idea of AI and intelligent robots has dominated thinking about the relationship between humans and computers. In part, this is because it's easy to tell the stories about AI and robots, and in part because of early successes (e.g., theorem provers that reproduced most of Whitehead and Russell's *Principia Mathematica*) and massive military funding. The earlier and broader vision of cybernetics, which considered the artificial as part of larger systems of feedback and mutual influence, faded from public awareness.

However, in the intervening years the cybernetics vision has slowly grown and quietly taken over—to the point where it is "in the air." State-of-the-art research in most engineering disciplines is now framed as feedback systems that are dynamic and driven by energy flows. Even AI is being recast as human/machine "advisor" systems, and the military is beginning large-scale funding in this area—something that should perhaps worry us more than drones and independent humanoid robots.

But as science and engineering have adopted a more cybernetics-like stance, it has become clear that even the vision of cybernetics is far too small. It was originally centered on the embeddedness of the individual actor but not on the emergent properties of a network of actors. This is unsurprising, because the mathematics of networks did not exist until recently, so a quantitative science of how networks behave was impossible. We now know that study of the individual does not produce understanding of the system except in certain simple cases. Recent progress in this area was foreshadowed by understanding that "chaos," and later "complexity," were the typical behavior of systems, but we can now go far beyond these statistical understandings.

We're beginning to be able to analyze, predict, and even design the emergent behavior of complex heterogeneous networks. The cybernetics view of the connected individual actor can now be expanded to cover complex systems of connected individuals and machines, and the insights we obtain from this broader view are fundamentally different from those obtained from the cybernetics view. Thinking about the network is analogous to thinking about entire ecosystems. How would you guide ecosystems to grow in a good direction? What do you even mean by "a good direction"? Questions like this are beyond the boundary of traditional cybernetic thinking.

Perhaps the most stunning realization is that humans are already beginning to use AI and machine learning to guide entire ecosystems, including ecosystems of people, thus creating human-AI ecologies. Now that everything is becoming "datafied," we can measure most aspects of human life and, increasingly, aspects of all life. This, together with new, powerful machine-learning techniques, means that we can build models of these ecologies in ways we couldn't before. Well-known examples are weather- and traffic-prediction models, which are being extended to predict the global climate and plan city growth and renewal. AI-aided engineering of the ecologies is already here.

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Development of human-AI ecosystems is perhaps inevitable for a social species such as ourselves. We became social early in our evolution, millions of years ago. We began exchanging information with one another to stay alive, to increase our fitness. We developed writing to share abstract and complex ideas, and most recently we've developed computers to enhance our communication abilities. Now we're developing AI and machine-learning models of ecosystems and sharing the predictions of those models to jointly shape our world through new laws and international agreements.

We live in an unprecedented historic moment, in which the availability of vast amounts of human behavioral data and advances in machine learning enable us to tackle complex social problems through algorithmic decision making. The opportunities for such a human-AI ecology to have positive social impact through fairer and more transparent decisions are obvious. But there are also risks of a "tyranny of algorithms," where unelected data experts are running the world. The choices we make now are perhaps even more momentous than those we faced in the 1950s, when AI and cybernetics were created. The issues look similar, but they're not. We have moved down the road, and now the scope is larger. It's not just AI robots versus individuals. It's AI guiding entire ecologies.

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How can we make a good human-artificial ecosystem, something that's not a machine society but a cyberculture in which we can all live as humans—a culture with a human feel to it? We don't want to think small—for example, to talk only of robots and self-driving cars. We want this to be a global ecology. Think Skynet-size. But how would you make Skynet something that's about the human fabric?

The first thing to ask is: What's the magic that makes the current AI work? Where is it wrong and where is it right?

The good magic is that it has something called the credit-assignment function. What that lets you do is take "stupid neurons"—little linear functions—and figure out, in a big network, which ones are doing the work and strengthen them. It's a way of taking a random bunch of switches all hooked together in a network and making them smart by giving them feedback about what works and what doesn't. This sounds simple, but there's some complicated math around it. That's the magic that makes current AI work.

The bad part of it is, because those little neurons are stupid, the things they learn don't generalize very well. If an AI sees something it hasn't seen before, or if the world changes a little bit, the AI is likely to make a horrible mistake. It has absolutely no sense of context. In some ways, it's as far from Norbert Wiener's original notion of cybernetics as you can get, because it isn't contextualized; it's a little idiot savant.

But imagine that you took away those limitations: Imagine that instead of using dumb neurons, you used neurons in which real-world knowledge was embedded. Maybe instead of linear neurons, you used neurons that were functions in physics, and then you tried to fit physics data. Or maybe you put in a lot of knowledge about humans and how they interact with one another—the statistics and characteristics of humans.

When you add this background knowledge and surround it with a good credit-assignment function, then you can take observational data and use the credit-assignment function to reinforce the functions that are producing good answers. The result is an AI that works extremely well and can generalize. For instance, in solving physical

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problems, it often takes only a couple of noisy data points to get something that's a beautiful description of a phenomenon, because you're putting in knowledge about how physics works. That's in huge contrast to normal AI, which requires millions of training examples and is very sensitive to noise. By adding the appropriate background knowledge, you get much more intelligence.

Similar to the physical-systems case, if we make neurons that know a lot about how humans learn from each other, then we can detect human fads and predict human behavior trends in surprisingly accurate and efficient ways. This "social physics" works because human behavior is determined as much by the patterns of our culture as by rational, individual thinking. These patterns can be described mathematically and employed to make accurate predictions.

This idea of a credit-assignment function reinforcing connections between neurons that are doing the best work is the core of current AI. If you make those little neurons smarter, the AI gets smarter. So, what would happen if we replaced the neurons with people? People have lots of capabilities. They know lots of things about the world; they can perceive things in a broadly competent, human way. What would happen if you had a network of people in which you could reinforce the connections that were helping and minimize the connections that weren't?

That begins to sound like a society, or a company. We all live in a human social network. We're reinforced for doing things that seem to help everybody and discouraged from doing things that are not appreciated. Culture is the result of this sort of human AI as applied to human problems; it is the process of building social structures by reinforcing the good connections and penalizing the bad. Once you've realized you can take this general AI framework and create a human AI, the question becomes, What's the right way to do that? Is it a safe idea? Is it completely crazy?

My students and I are looking at how people make decisions, on huge databases of financial decisions, business decisions, and many other sorts of decisions. What we've found is that humans often make decisions in a way that mimics AI credit-assignment algorithms and works to make the community smarter. A particularly interesting feature of this work is that it addresses a classic problem in evolution known as the group-selection problem. The core of this problem is: How can we select for culture in evolution, when it's the individuals that reproduce? What you need is something that selects for the best cultures and the best groups but also selects for the best individuals, because they're the units that transmit the genes.

When you frame the question this way and go through the mathematical literature, you discover that there's one generally best way to do this. It's called "distributed Thompson sampling," a mathematical algorithm used in choosing, out of a set of possible actions with unknown payoffs, the action that maximizes the expected reward in respect to the actions. The key is social sampling, a way of combining evidence, of exploring and exploiting at the same time. It has the unusual property of simultaneously being the best strategy both for the individual and for the group. If you use the group as the basis of selection, and then the group either gets wiped out or reinforced, you're also selecting for successful individuals. If you select for individuals, and each individual does what's good for him or her, then that's automatically the best thing for the group. It's an amazing alignment of interests and utilities, and it provides real insight into the question of how culture fits into natural selection.

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Social sampling, very simply, is looking around you at the actions of people who are like you, finding what's popular, and then copying it if it seems like a good idea to you. Idea propagation has this popularity function driving it, but individual adoption also is about figuring out how the idea works for the individual—a reflective attitude. When you combine social sampling and personal judgment, you get superior decision making. That's amazing, because now we have a mathematical recipe for doing with humans what all those AI techniques are doing with dumb computer neurons. We have a way of putting people together to make better decisions, given more and more experience.

So, what happens in the real world? Why don't we do this all the time? Well, people are good at it, but there are ways it can run amok. One of these is through advertising, propaganda, or "fake news." There are many ways to get people to think something is popular when it's not, and this destroys the usefulness of social sampling. The way you can make groups of people smarter, the way you can make human AI, will work only if you can get feedback to them that's truthful. It must be grounded on whether each person's actions worked for them or not.

That's the key to AI mechanisms, too. What they do is analyze whether they performed correctly. If so, plus one; if not, minus one. We need that truthful feedback to make this human mechanism work well, and we need good ways of knowing about what other people are doing so that we can correctly assess popularity and the likelihood of this being a good choice.

The next step is to build this credit-assignment function, this feedback function, for people, so that we can make a good human-artificial ecosystem—a smart organization and a smart culture. In a way, we need to duplicate some of the early insights that resulted in, for instance, the U.S. census—trying to find basic facts that everybody can agree on and understand so that the transmission of knowledge and culture can happen in a way that's truthful and social sampling can function efficiently.

We can address the problem of building an accurate credit-assignment function in many different settings. In companies, for instance, it can be done with digital ID badges that reveal who's connected to whom, so that we can assess the pattern of connections in relation to the company's results on a daily or weekly basis. The credit-assignment function asks whether those connections helped solve problems, or helped invent new solutions, and reinforces the helpful connections. When you can get that feedback quantitatively—which is difficult, because most things aren't measured quantitatively—both the productivity and the innovation rate within the organization can be significantly improved. This is, for instance, the basis of Toyota's "continuous improvement" method.

A next step is to try to do the same thing but at scale, something I refer to as building a trust network for data. It can be thought of as a distributed system like the Internet, but with the ability to quantitatively measure and communicate the qualities of human society, in the same way that the U.S. census does a pretty good job of telling us about population and life expectancy. We are already deploying prototype examples of trust networks at scale in several countries, based on the data and measurement standards laid out in the U.N. Sustainable Development Goals.

On the horizon is a vision of how we can make humanity more intelligent by building a human AI. It's a vision composed of two threads. One is data that we can all trust—data that have been vetted by a broad community, data where the algorithms are known and monitored, much like the census data we all automatically rely on as at least

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approximately correct. The other is a fair, data-driven assessment of public norms, policy, and government, based on trusted data about current conditions. This second thread depends on availability of trusted data and so is just beginning to be developed. Trusted data and data-driven assessment of norms, policy, and government together create a credit-assignment function that improves societies' overall fitness and intelligence.

It is precisely at the point of creating greater societal intelligence where fake news, propaganda, and advertising all get in the way. Fortunately, trust networks give us a path forward to building a society more resistant to echo-chamber problems, these fads, these exercises in madness. We have begun to develop a new way of establishing social measurements, in aid of curing some of the ills we see in society today. We're using open data from all sources, encouraging a fair representation of the things people are choosing, in a curated mathematical framework that can stamp out the echoes and the attempts to manipulate us.

On Polarization and Inequality

Extreme polarization and segregation by income are almost everywhere in the world today and threaten to tear governments and civil society apart. Increasingly, the media are becoming adrenaline pushers driven by advertising clicks and failing to deliver balanced facts and reasoned discourse—and the degradation of media is causing people to lose their bearings. They don't know what to believe, and thus they can easily be manipulated. There is a real need to ground our various cultures in trustworthy, data-driven standards that we all agree on, and to be able to know what behaviors and policies work and which don't.

In converting to a digital society, we've lost touch with traditional notions of truth and justice. Justice used to be mostly informal and normative. We've now formalized it. At the same time, we've put it out of reach for most people. Our legal systems are failing us in a way they didn't before, precisely because they're now more formal, more digital, less embedded in society.

Ideas about justice are very different around the world. One of the core differentiators is this: Do you or your parents remember when the bad guys came with guns and took everything? If you do, your attitude about justice is different from that of the average reader of this essay. Do you come from the upper classes? Or were you somebody who saw the sewers from the inside? Your view of justice depends on your history.

A common test I have for U.S. citizens is this: Do you know anybody who owns a pickup truck? It's the number-one-selling vehicle in the United States, and if you don't know people like that, you're out of touch with more than 50 percent of Americans. Physical segregation drives conceptual segregation. Most of America thinks of justice and access and fairness in terms very different from those of the typical, say, Manhattanite.

If you look at patterns of mobility—where people go—in a typical city, you find that the people in the top quintile (white-collar working families) and bottom quintile (people who are sometimes on unemployment or welfare) almost never talk to each other. They don't go to the same places; they don't talk about the same things. They all live in

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the same city, nominally, but it's as if it were two completely different cities—and this is perhaps the most important cause of today's plague of polarization.

On Extreme Wealth

Some two hundred of the world's wealthiest people have pledged to give away more than 50 percent of their wealth either during their lifetimes or in their wills, creating a plurality of voices in the foundation space.[36] Bill Gates is probably the most familiar example. He's decided that if the government won't do it, he'll do it. You want mosquito nets? He'll do it. You want antivirals? He'll do it. We're getting different stakeholders to take action in the form of foundations dedicated to public good, and they have different versions of what they consider the public good. This diversity of goals has created a lot of what's wonderful about the world today. Actions from outside government by organizations like the Ford Foundation and the Sloan Foundation, who bet on things that nobody else would bet on, have changed the world for the better.

Sure, these billionaires are human, with human foibles, and all is not necessarily as it should be. On the other hand, the same situation obtained when the railways were first built. Some people made huge fortunes. A lot of people went bust. We, the average people, got railways out of it. That's good. Same thing with electric power; same thing with many new technologies. There's a churning process that throws somebody up and later casts them or their heirs down. Bubbles of extreme wealth were a feature of the late 1800s and early 1900s when steam engines and railways and electric lights were invented. The fortunes they created were all gone within two or three generations.

If the U.S. were like Europe, I would worry. What you find in Europe is that the same families have held on to wealth for hundreds of years, so they're entrenched not just in terms of wealth but of the political system and in other ways. But so far, the U.S. has avoided this kind of hereditary class system. Extreme wealth hasn't stuck, which is good. It shouldn't stick. If you win the lottery, you get your billion dollars, but your grandkids ought to work for a living.

On AI and Society

People are scared about AI. Perhaps they should be. But they need to realize that AI feeds on data. Without data, AI is nothing. You don't have to watch the AI; instead you should watch what it eats and what it does. The trust-network framework we've set up, with the help of nations in the E.U. and elsewhere, is one where we can have our algorithms, we can have our AI, but we get to see what went in and what went out, so that we can ask, Is this a discriminatory decision? Is this the sort of thing that we want as humans? Or is this something that's a little weird?

The most revealing analogy is that regulators, bureaucracies, and parts of the government are very much like AIs: They take in the rules that we call law and regulation, and they add government data, and they make decisions that affect our lives. The part that's bad about the current system is that we have very little oversight of these departments, regulators, and bureaucracies. The only control we have is the vote—the opportunity to elect somebody different. We need to make oversight of bureaucracies a lot more fine-grained. We need to record the data that went into every single decision

[36] https://givingpledge.org/About.aspx.

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and have the results analyzed by the various stakeholders—rather like elected legislatures were originally intended to do.

If we have the data that go into and out of each decision, we can easily ask, Is this a fair algorithm? Is this AI doing things that we as humans believe are ethical? This human-in-the-loop approach is called "open algorithms;" you get to see what the AIs take as input and what they decide using that input. If you see those two things, you'll know whether they're doing the right thing or the wrong thing. It turns out that's not hard to do. If you control the data, then you control the AI.

One thing people often fail to mention is that all the worries about AI are the same as the worries about today's government. For most parts of the government—the justice system, et cetera—there's no reliable data about what they're doing and in what situation. How can you know whether the courts are fair or not if you don't know the inputs and the outputs? The same problem arises with AI systems and is addressable in the same way. We need trusted data to hold current government to account in terms of what they take in and what they put out, and AI should be no different.

Next-Generation AI

Current AI machine-learning algorithms are, at their core, dead simple stupid. They work, but they work by brute force, so they need hundreds of millions of samples. They work because you can approximate anything with lots of little simple pieces. That's a key insight of current AI research—that if you use reinforcement learning for credit-assignment feedback, you can get those little pieces to approximate whatever arbitrary function you want.

But using the wrong functions to make decisions means the AI's ability to make good decisions won't generalize. If we give the AI new, different inputs, it may make completely unreasonable decisions. Or if the situation changes, then you need to retrain it. There are amusing techniques to find the "null space" in these AI systems. These are inputs that the AI thinks are valid examples of what it was trained to recognize (e.g., faces, cats, etc.), but to a human they're crazy examples.

Current AI is doing descriptive statistics in a way that's not science and would be almost impossible to make into science. To build robust systems, we need to know the science behind data. The systems I view as next-generation AIs result from this science-based approach: If you're going to create an AI to deal with something physical, then you should build the laws of physics into it as your descriptive functions, in place of those stupid little neurons. For instance, we know that physics uses functions like polynomials, sine waves, and exponentials, so those should be your basis functions and not little linear neurons. By using those more appropriate basis functions, you need a lot less data, you can deal with a lot more noise, and you get much better results.

As in the physics example, if we want to build an AI to work with human behavior, then we need to build the statistical properties of human networks into machine-learning algorithms. When you replace the stupid neurons with ones that capture the basics of human behavior, then you can identify trends with very little data, and you can deal with huge levels of noise.

The fact that humans have a "commonsense" understanding that they bring to most problems suggests what I call the human strategy: Human society is a network just like the neural nets trained for deep learning, but the "neurons" in human society are a lot

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smarter. You and I have surprisingly general descriptive powers that we use for understanding a wide range of situations, and we can recognize which connections should be reinforced. That means we can shape our social networks to work much better and potentially beat all that machine-based AI at its own game.

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"URGENT!" URGENT!" the cc'd copy of an email screamed, one of a dozen emails that greeted me as I turned on my phone at the baggage carousel at Malpensa Airport after the long flight from JFK. "The great American visionary thinker John Brockman arrives this morning at Grand Hotel Milan. You MUST, repeat MUST pay him a visit." It was signed HUO.

The prior evening, waiting in the lounge at JFK, I had had the bright idea to write my friend and longtime collaborator, the London-based, peripatetic art curator **Hans Ulrich Obrist (***known to all as HUO), and ask if there was anyone in Milan I should know.*

Once I was settled at the hotel, the phone began ringing and a procession of leading Italian artists, designers, and architects called to request a meeting, including Enzo Mari, the modernist artist and furniture designer; Alberto Garutti, whose aesthetic strategies have inspired a dialogue between contemporary art, spectator, and public space; and fashion designer Miuccia Prada, who "requests your presence for tea this afternoon at Prada headquarters." And thus, thanks to HUO, did the jet-lagged "great American visionary thinker" stumble and mumble his way through his first day in Milan, November 2011.

HUO is sui generis*: He lives a twenty-four-hour day, sleeping (I guess) whenever, and employing full-time assistants who work eight-hour shifts and are available to him 24/7. Over a recent two-year period, he visited art venues in either China or India for forty weekends each year—departing London Thursday evening, back at his desk on Monday. Last year, once again,* ArtReview *ranked him #1 on their annual "Power 100" list.*

Recently we collaborated on a panel during the "GUEST, GHOST, HOST: MACHINE!" Serpentine event that took place at London's new City Hall. We were joined by Venki Ramakrishnan, Jaan Tallinn, and Andrew Blake, research director of The Alan Turing Institute. The event was consistent with HUO's mission of bringing together art and science: "The curator is no longer understood simply as the person who fills a space with objects," he says, "but also as the person who brings different cultural spheres into contact, invents new display features, and makes junctions that allow unexpected encounters and results."

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MAKING THE INVISIBLE VISIBLE: ART MEETS AI

Hans Ulrich Obrist

Hans Ulrich Obrist *is artistic director of the Serpentine Gallery, London, and the author of* Ways of Curating *and* Lives of the Artists, Lives of the Architects.

In the Introduction to the second edition of his book *Understanding Media*, Marshall McLuhan noted the ability of art to "anticipate future social and technological developments." Art is "an early alarm system," pointing us to new developments in times ahead and allowing us "to prepare to cope with them. . . . Art as a radar environment takes on the function of indispensable perceptual training. . . ."

In 1964, when McLuhan's book was first published, the artist Nam June Paik was just building his *Robot K-456* to experiment with the technologies that subsequently would start to influence society. He had worked with television earlier, challenging its usual passive consumption by the viewer, and later made art with global live-satellite broadcasts, using the new media less for entertainment than to point us to their poetic and intercultural capacities (which are still mostly unused today). The Paiks of our time, of course, are now working with the Internet, digital images, and artificial intelligence. Their works and thoughts, again, are an early alarm system for the developments ahead of us.

As a curator, my daily work is to bring together different works of art and connect different cultures. Since the early 1990s, I have also been organizing conversations and meetings with practitioners from different disciplines, in order to go beyond the general reluctance to pool knowledge. Since I was interested in hearing what artists have to say about artificial intelligence, I recently organized several conversations between artists and engineers.

The reason to look closely at AI is that two of the most important questions of today are "How capable will AI become?" and "What dangers may arise from it?" Its early applications already influence our everyday lives in ways that are more or less recognizable. There is an increasing impact on many aspects of our society, but whether this might be, in general, beneficial or malign is still uncertain.

Many contemporary artists are following these developments closely. They are articulating various doubts about the promises of AI and reminding us not to associate the term "artificial intelligence" solely with positive outcomes. To the current discussions of AI, the artists contribute their specific perspectives and notably their focus on questions of image making, creativity, and the use of programming as artistic tools.

The deep connections between science and art had already been noted by the late Heinz von Foerster, one of the architects of cybernetics, who worked with Norbert Wiener from the mid-1940s and in the 1960s founded the field of second-order cybernetics, in which the observer is understood as part of the system itself and not an external entity. I knew von Foerster well, and in one of our many conversations, he offered his views on the relation between art and science:

> I've always perceived art and science as complementary fields. One shouldn't forget that a scientist is in some respects also an artist. He invents a new technique and he describes it. He uses language like a poet, or the author of a detective novel, and describes his findings. In my view, a scientist must work in

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> an artistic way if he wants to communicate his research. He obviously wants to communicate and talk to others. A scientist invents new objects, and the question is how to describe them. In all of these aspects, science is not very different from art.

When I asked him how he defined cybernetics, von Foerster answered:

> The substance of what we have learned from cybernetics is to think in circles: *A* leads *B, B* to *C,* but *C* can return to *A*. Such kinds of arguments are not linear but circular. The significant contribution of cybernetics to our thinking is to accept circular arguments. This means that we have to look at circular processes and understand under which circumstances an equilibrium, and thus a stable structure, emerges.

Today, where AI algorithms are applied in daily tasks, one can ask how the human factor is included in these kinds of processes and what role creativity and art could play in relation to them. There are thus different levels to think about when exploring the relation between AI and art.

So, what do contemporary artists have to say about artificial intelligence?

Artificial Stupidity

Hito Steyerl, an artist who works with documentary and experimental film, considers two key aspects that we should keep in mind when reflecting on the implications of AI for society. First, the expectations for so-called artificial intelligence, she says, are often overrated, and the noun "intelligence" is misleading; to counter that, she uses the term "artificial stupidity." Second, she points out that programmers are now making invisible software algorithms visible through images, but to understand and interpret these images better, we should apply the expertise of artists.

Steyerl has worked with computer technology for many years, and her recent artworks have explored surveillance techniques, robots, and such computer games as in *How Not to Be Seen* (2013), on digital-image technologies, or *HellYeahWeFuckDie* (2017), about the training of robots in the still-difficult task of keeping balance. But to explain her notion of artificial stupidity, Steyerl refers to a more general phenomenon, like the now widespread use of Twitter bots, noting in our conversation:

> It was and still is a very popular tool in elections to deploy Twitter armies to sway public opinion and deflect popular hashtags and so on. This is an artificial intelligence of a very, very low grade. It's two or maybe three lines of script. It's nothing very sophisticated at all. Yet the social implications of this kind of artificial stupidity, as I call it, are already monumental in global politics.

As has been widely noted, this kind of technology was seen in the many automated Twitter posts before the 2016 U.S. presidential election and also shortly before the Brexit vote. If even low-grade AI technology like these bots are already influencing our politics, this raises another urgent question: "How powerful will far more advanced techniques be in the future?"

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Visible / Invisible

The artist Paul Klee often talked about art as "making the invisible visible." In computer technology, most algorithms work invisibly, in the background; they remain inaccessible in the systems we use daily. But lately there has been an interesting comeback of visuality in machine learning. The ways that the deep-learning algorithms of AI are processing data have been made visible through applications like Google's DeepDream, in which the process of computerized pattern-recognition is visualized in real time. The application shows how the algorithm tries to match animal forms with any given input. There are many other AI visualization programs that, in their way, also "make the invisible visible." The difficulty in the general public perception of such images is, in Steyerl's view, that these visual patterns are viewed uncritically as realistic and objective representations of the machine process. She says of the aesthetics of such visualizations:

> For me, this proves that science has become a subgenre of art history. . . . We now have lots of abstract computer patterns that might look like a Paul Klee painting, or a Mark Rothko, or all sorts of other abstractions that we know from art history. The only difference, I think, is that in current scientific thought they're perceived as representations of reality, almost like documentary images, whereas in art history there's a very nuanced understanding of different kinds of abstraction.

What she seeks is a more profound understanding of computer-generated images and the different aesthetic forms they use. They are obviously not generated with the explicit goal of following a certain aesthetic tradition. The computer engineer Mike Tyka, in a conversation with Steyerl, explained the functions of these images:

> Deep-learning systems, especially the visual ones, are really inspired by the need to know what's going on in the black box. Their goal is to project these processes back into the real world.

Nevertheless, these images have aesthetic implications and values which have to be taken into account. One could say that while the programmers use these images to help us better understand the programs' algorithms, we need the knowledge of artists to better understand the aesthetic forms of AI. As Steyerl has pointed out, such visualizations are generally understood as "true" representations of processes, but we should pay attention to their respective aesthetics, and their implications, which have to be viewed in a critical and analytical way.

In 2017, the artist Trevor Paglen created a project to make these invisible AI algorithms visible. In *Sight Machine*, he filmed a live performance of the Kronos Quartet and processed the resulting images with various computer software programs used for face detection, object identification, and even for missile guidance. He projected the outcome of these algorithms, in real time, back to screens above the stage. By demonstrating how the various different programs interpreted the musicians' performance, Paglen showed that AI algorithms are always determined by sets of values and interests which they then manifest and reiterate, and thus must be critically questioned. The significant contrast between algorithms and music also raises the issue of relationships between technical and human perception.

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Computers, as a Tool for Creativity, Can't Replace the Artist.
Rachel Rose, a video artist who thinks about the questions posed by AI, employs computer technology in the creation of her works. Her films give the viewer an experience of materiality through the moving image. She uses collaging and layering of the material to manipulate sound and image, and the editing process is perhaps the most important aspect of her work.

She also talks about the importance of decision making in her work. For her, the artistic process does not follow a rational pattern. In a converation we had, together with the engineer Kenric McDowell, at the Google Cultural Institute, she explained this by citing a story from theater director Peter Brook's 1968 book *The Empty Space*. When Brook designed the set for his production of *The Tempest* in the late 1960s, he started by making a Japanese garden, but then the design evolved, becoming a white box, a black box, a realistic set, and so on. And in the end, he returned to his original idea. Brook writes that he was shocked at having spent a month on his labors, only to end at the beginning. But this shows that the creative artistic process is a succession whose every step builds on the next and which eventually comes to an unpredictable conclusion. The process is not a logical or rational succession but has mostly to do with the artist's feelings in reaction to the preceding result. Rose said, of her own artistic decision making:

> It, to me, is distinctively different from machine learning, because at each decision there's this core feeling that comes from a human being, which has to do with empathy, which has to do with communication, which has to do with questions about our own mortality that only a human could ask.

This point underlines the fundamental difference between any human artistic production and so-called computer creativity. Rose sees AI more as a possible way to create better tools for humans:

> A place I can imagine machine learning working for an artist would be not in developing an independent subjectivity, like writing a poem or making an image, but actually in filling in gaps that are to do with labor, like the way that Photoshop works with different tools that you can use.

And though such tools may not seem spectacular, she says, "they might have a larger influence on art," because they provide artists with further possibilities in their creative work.

McDowell added that he, too, believes there are false expectations around AI. "I've observed," he said, "that there's a sort of magical quality to the idea of a computer that does all the things that we do." He continued: "There's almost this kind of demonic mirror that we look into, and we want it to write a novel, we want it to make a film—we want to give that away somehow." He is instead working on projects wherein humans collaborate with the machine. One of the current aims of AI research is to find new means of interaction between humans and software. And art, one could say, needs to play a key role in that enterprise, since it focuses on our subjectivity and on essential human aspects like empathy and mortality.

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Cybernetics / Art

Suzanne Treister is an artist whose work from 2009 to 2011 serves as an example of what is happening at the intersection of our current technologies, the arts, and cybernetics. Treister has been a pioneer in digital art since the 1990s, inventing, for example, imaginary video games and painting screen shots from them. In her project *Hexen 2.0* she looked back at the famous Macy conferences on cybernetics that between 1946 and 1953 were organized in New York by engineers and social scientists to unite the sciences and to develop a universal theory of the workings of the mind.

In her project, she created thirty photo-text works about the conference attendees (which included Wiener and von Foerster), she invented tarot cards, and she made a video based on a photomontage of a "cybernetic séance." In the "séance," the conference participants are seen sitting at a round table, as in spiritualist séances, while certain of their statements on cybernetics are heard in an audio-collage—rational knowledge and superstition combined. She also noted that some of the participating scientists worked for the military; thus the application of cybernetics could be seen in an ambivalent way, even back then, as a tussle between pure knowledge and its use in state control.

If one looks at Treister's work about the Macy conference participants, one sees that no visual artist was included. A dialogue between artists and scientists would be fruitful in future discussions, and it is a bit astonishing that this wasn't realized at the time, given von Foerster's keen interest in art. He recounted in one of our conversations how his relation to the field dated back to his childhood:

> I grew up as a child in an artistic family. We often had visits from poets, philosophers, painters, and sculptors. Art was a part of my life. Later, I got into physics, as I was talented in this subject. But I always remained conscious of the importance of art for science. There wasn't a great difference for me. For me, both aspects of life have always been very much alike—and accessible, too. We should see them as one. An artist also has to reflect on his work. He has to think about his grammar and his language. A painter must know how to handle his colors. Just think of how intensively oil colors were researched during the Renaissance. They wanted to know how a certain pigment could be mixed with others to get a certain tone of red or blue. Chemists and painters collaborated very closely. I think the artificial division between science and art is wrong.

Though for von Foerster the relation between the art and science was always clear, for our own time this connection remains to be made. There are many reasons to multiply the links. The critical thinking of artists would be beneficial in respect to the dangers of AI, since they draw our attention to questions they consider essential from their perspective. With the advent of machine learning, new tools are available to artists for their work. And as the algorithms of AI are made visible through artificial images in new ways, artists' critical visual knowledge and expertise will be harnessed. Many of the key questions of AI are philosophical in nature and can be answered only from a holistic point of view. The way they play out among adventurous artists will be worth following.

Simulating Worlds

For the most part, the works of contemporary artists have been embodied ruminations on

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AI's impact on existential questions of the self and our future interaction with nonhuman entities. Few, though, have taken the technologies and innovations of AI as the underlying materials of their work and sculpted them to their own vision. An exception is the artist Ian Cheng, who has gone as far as to construct entire worlds of artificial beings with varying degrees of sentience and intelligence. He refers to these worlds as Live Simulations. His *Emissaries* trilogy (2015-2017) is set in a fictional postapocalyptic world of flora and fauna, in which AI-driven animals and creatures explore the landscape and interact with each other. Cheng uses advanced graphics but has them programmed with a lot of glitches and imperfections, which imparts a futuristic and anachronistic atmosphere at the same time. Through his trilogy, which charts a history of consciousness, he asks the question "What is a simulation?"

While the majority of artistic works that utilize recent developments in AI specifically draw from the field of machine learning, Cheng's Live Simulations take a separate route. The protagonists and plot lines that are interlaced in each episodic simulation of *Emissaries* use the complex logic systems and rules of AI. What is profound about his continually evolving scenes is that complexity arises not through the desire/actions of any single actor or artificial godhead but instead through their constellation, collision, and constant evolution in symbiosis with one another. This gives rise to unexpected outcomes and unending, unknowable situations—you can never experience the exact same moment in successive viewings of his work.

Cheng had a discussion at the Serpentine Marathon "GUEST, GHOST, HOST: MACHINE!" with the programmer Richard Evans, who recently designed Versu, an AI-based platform for interactive storytelling games. Evans' work emphasizes the social interaction of the games' characters, who react in a spectrum of possible behaviors to the choices made by the human players. In their conversation, Evans said that a starting point for the project was that most earlier simulation video games, such as *The Sims*, did not sufficiently take into account the importance of social practices. Simulated protagonists in games would often act in ways that did not correspond well with real human behavior. Knowledge of social practices limits the possibilities of action but is necessary to understand the meaning of our actions—which is what interests Cheng for his own simulations. The more parameters of actions in certain circumstances are determined in a computer simulation, the more interesting it is for Cheng to experiment with individual and specific changes. He told Evans, "I gather that if we had AI with more ability to respond to social contexts, tweaking one thing, you would get something quite artistic and beautiful."

Cheng also sees the work of programmers and AI simulations as creating new and sophisticated tools for experimenting with the parameters of our daily social practices. In this way, the involvement of artists in AI will lead to new kinds of open experiments in Art. Such possibilities are—like increased AI capabilities in general—still in the future. Recognizing that this is an experimental technology in its infancy, very far from apocalyptic visions of a superintelligent AI takeover, Cheng fills his simulations with prosaic avatars such as strange microbial globules, dogs, and the undead.

Discussions like these, between artists and engineers, of course are not totally new. In the 1960s, the engineer Billy Klüver brought artists together with engineers in a series of events, and in 1967 he founded the Experiments in Art and Technology program with Robert Rauschenberg and others. In London, at around the same time, Barbara

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Stevini and John Latham, of the Artist Placement Group, took things a step further by asserting that there should be artists in residence in every company and every government. Today, these inspiring historical models can be applied to the field of AI. As AI comes to inhabit more and more of our everyday lives, the creation of a space that is nondeterministic and non-utilitarian in its plurality of perspectives and diversity of understandings will undoubtedly be essential.

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Alison Gopnik *is an international leader in the field of children's learning and development and was one of the founders of the field of "theory of mind." She has spoken of the child brain as a "powerful learning computer," perhaps from personal experience. Her own Philadelphia childhood was an exercise in intellectual development. "Other families took their kids to see* The Sound of Music *or* Carousel*; we saw Racine's* Phaedra *and Samuel Beckett's* Endgame," *she has recalled. "Our family read Henry Fielding's 18th-century novel* Joseph Andrews *out loud to each other around the fire on camping trips."*

Lately she has invoked Bayesian models of machine learning to explain the remarkable ability of preschoolers to draw conclusions about the world around them without benefit of enormous data sets. "I think babies and children are actually more conscious than we are as adults," she has said. "They're very good at taking in lots of information from lots of different sources at once." She has referred to babies and young children as "the research and development division of the human species." Not that she treats them coldly, as if they were mere laboratory animals. They appear to revel in her company, and in the blinking, thrumming toys in her Berkeley lab. For years after her own children had outgrown it, she kept a playpen in her office.

Her investigations into just how we learn, and the parallels to the deep-learning methods of AI, continues. "It turns out to be much easier to simulate the reasoning of a highly trained adult expert than to mimic the ordinary learning of every baby," she says. "Computation is still the best—indeed, the only—scientific explanation we have of how a physical object like a brain can act intelligently. But, at least for now, we have almost no idea at all how the sort of creativity we see in children is possible."

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AIs VERSUS FOUR-YEAR-OLDS
Alison Gopnik

***Alison Gopnik** is a developmental psychologist at UC Berkeley; her books include* The Philosophical Baby *and, most recently,* The Gardener and the Carpenter: What the New Science of Child Development Tells Us About the Relationship Between Parents and Children.

Everyone's heard about the new advances in artificial intelligence, and especially machine learning. You've also heard utopian or apocalyptic predictions about what those advances mean. They have been taken to presage either immortality or the end of the world, and a lot has been written about both those possibilities. But the most sophisticated AIs are still far from being able to solve problems that human four-year-olds accomplish with ease. In spite of the impressive name, artificial intelligence largely consists of techniques to detect statistical patterns in large data sets. There is much more to human learning.

How can we possibly know so much about the world around us? We learn an enormous amount even when we are small children; four-year-olds already know about plants and animals and machines; desires, beliefs, and emotions; even dinosaurs and spaceships.

Science has extended our knowledge about the world to the unimaginably large and the infinitesimally small, to the edge of the universe and the beginning of time. And we use that knowledge to make new classifications and predictions, imagine new possibilities, and make new things happen in the world. But all that reaches any of us from the world is a stream of photons hitting our retinas and disturbances of air at our eardrums. How do we learn so much about the world when the evidence we have is so limited? And how do we do all this with the few pounds of grey goo that sits behind our eyes?

The best answer so far is that our brains perform computations on the concrete, particular, messy data arriving at our senses, and those computations yield accurate representations of the world. The representations seem to be structured, abstract, and hierarchical; they include the perception of three-dimensional objects, the grammars that underlie language, and mental capacities like "theory of mind," which lets us understand what other people think. Those representations allow us to make a wide range of new predictions and imagine many new possibilities in a distinctively creative human way.

This kind of learning isn't the only kind of intelligence, but it's a particularly important one for human beings. And it's the kind of intelligence that is a specialty of young children. Although children are dramatically bad at planning and decision making, they are the best learners in the universe. Much of the process of turning data into theories happens before we are five.

Since Aristotle and Plato, there have been two basic ways of addressing the problem of how we know what we know, and they are still the main approaches in machine learning. Aristotle approached the problem from the bottom up: Start with senses—the stream of photons and air vibrations (or the pixels or sound samples of a digital image or recording)—and see if you can extract patterns from them. This approach was carried further by such classic associationists as philosophers David Hume

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and J. S. Mill and later by behavioral psychologists, like Pavlov and B. F. Skinner. On this view, the abstractness and hierarchical structure of representations is something of an illusion, or at least an epiphenomenon. All the work can be done by association and pattern detection—especially if there are enough data.

Over time, there has been a seesaw between this bottom-up approach to the mystery of learning and Plato's alternative, top-down one. Maybe we get abstract knowledge from concrete data because we already know a lot, and especially because we already have an array of basic abstract concepts, thanks to evolution. Like scientists, we can use those concepts to formulate hypotheses about the world. Then, instead of trying to extract patterns from the raw data, we can make predictions about what the data should look like if those hypotheses are right. Along with Plato, such "rationalist" philosophers and psychologists as Descartes and Noam Chomsky took this approach.

Here's an everyday example that illustrates the difference between the two methods: solving the spam plague. The data consist of a long unsorted list of messages in your in-box. The reality is that some of these messages are genuine and some are spam. How can you use the data to discriminate between them?

Consider the bottom-up technique first. You notice that the spam messages tend to have particular features: a long list of addressees, origins in Nigeria, references to million-dollar prizes or Viagra. The trouble is that perfectly useful messages might have these features, too. If you looked at enough examples of spam and non-spam emails, you might see not only that spam emails tend to have those features but that the features tend to go together in particular ways (Nigeria plus a million dollars spells trouble). In fact, there might be some subtle higher-level correlations that discriminate the spam messages from the useful ones—a particular pattern of misspellings and IP addresses, say. If you detect those patterns, you can filter out the spam.

The bottom-up machine-learning techniques do just this. The learner gets millions of examples, each with some set of features and each labeled as spam (or some other category) or not. The computer can extract the pattern of features that distinguishes the two, even if it's quite subtle.

How about the top-down approach? I get an email from the editor of the *Journal of Clinical Biology*. It refers to one of my papers and says that they would like to publish an article by me. No Nigeria, no Viagra, no million dollars; the email doesn't have any of the features of spam. But by using what I already know, and thinking in an abstract way about the process that produces spam, I can figure out that this email is suspicious.

(1) I know that spammers try to extract money from people by appealing to human greed.

(2) I also know that legitimate "open access" journals have started covering their costs by charging authors instead of subscribers, and that I don't practice anything like clinical biology.

Put all that together and I can produce a good new hypothesis about where that email came from. It's designed to sucker academics into paying to "publish" an article in a fake journal. The email was a result of the same dubious process as the other spam emails, even though it looked nothing like them. I can draw this conclusion from just one example, and I can go on to test my hypothesis further, beyond anything in the email itself, by googling the "editor."

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In computer terms, I started out with a "generative model" that includes abstract concepts like greed and deception and describes the process that produces email scams. That lets me recognize the classic Nigerian email spam, but it also lets me imagine many different kinds of possible spam. When I get the journal email, I can work backward: "This seems like just the kind of mail that would come out of a spam-generating process."

The new excitement about AI comes because AI researchers have recently produced powerful and effective versions of both these learning methods. But there is nothing profoundly new about the methods themselves.

Bottom-up Deep Learning

In the 1980s, computer scientists devised an ingenious way to get computers to detect patterns in data: connectionist, or neural-network, architecture (the "neural" part was, and still is, metaphorical). The approach fell into the doldrums in the '90s but has recently been revived with powerful "deep-learning" methods like Google's DeepMind.

For example, you can give a deep-learning program a bunch of Internet images labeled "cat," others labeled "house," and so on. The program can detect the patterns differentiating the two sets of images and use that information to label new images correctly. Some kinds of machine learning, called unsupervised learning, can detect patterns in data with no labels at all; they simply look for clusters of features—what scientists call a factor analysis. In the deep-learning machines, these processes are repeated at different levels. Some programs can even discover relevant features from the raw data of pixels or sounds; the computer might begin by detecting the patterns in the raw image that correspond to edges and lines and then find the patterns in those patterns that correspond to faces, and so on.

Another bottom-up technique with a long history is reinforcement learning. In the 1950s, B. F. Skinner, building on the work of John Watson, famously programmed pigeons to perform elaborate actions—even guiding air-launched missiles to their targets (a disturbing echo of recent AI) by giving them a particular schedule of rewards and punishments. The essential idea was that actions that were rewarded would be repeated and those that were punished would not, until the desired behavior was achieved. Even in Skinner's day, this simple process, repeated over and over, could lead to complex behavior. Computers are designed to perform simple operations over and over on a scale that dwarfs human imagination, and computational systems can learn remarkably complex skills in this way.

For example, researchers at Google's DeepMind used a combination of deep learning and reinforcement learning to teach a computer to play Atari video games. The computer knew nothing about how the games worked. It began by acting randomly and got information only about what the screen looked like at each moment and how well it had scored. Deep learning helped interpret the features on the screen, and reinforcement learning rewarded the system for higher scores. The computer got very good at playing several of the games, but it also completely bombed on others just as easy for humans to master.

A similar combination of deep learning and reinforcement learning has enabled the success of DeepMind's AlphaZero, a program that managed to beat human players at both chess and Go, equipped only with a basic knowledge of the rules of the game and

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some planning capacities. AlphaZero has another interesting feature: It works by playing hundreds of millions of games against itself. As it does so, it prunes mistakes that led to losses, and it repeats and elaborates on strategies that led to wins. Such systems, and others involving techniques called generative adversarial networks, generate data as well as observing data.

When you have the computational power to apply those techniques to very large data sets or millions of email messages, Instagram images, or voice recordings, you can solve problems that seemed very difficult before. That's the source of much of the excitement in computer science. But it's worth remembering that those problems—like recognizing that an image is a cat or a spoken word is "Siri"—are trivial for a human toddler. One of the most interesting discoveries of computer science is that problems that are easy for us (like identifying cats) are hard for computers—much harder than playing chess or Go. Computers need millions of examples to categorize objects that we can categorize with just a few. These bottom-up systems can generalize to new examples; they can label a new image as a "cat" fairly accurately, over all. But they do so in ways quite different from how humans generalize. Some images almost identical to a cat image won't be identified by us as cats at all. Others that look like a random blur will be.

Top-down Bayesian Models

The top-down approach played a big role in early AI, and in the 2000s it, too, experienced a revival, in the form of probabilistic, or Bayesian, generative models.

The early attempts to use this approach faced two kinds of problems. First, most patterns of evidence might in principle be explained by many different hypotheses: It's possible that my journal email message is genuine, it just doesn't seem likely. Second, where do the concepts that the generative models use come from in the first place? Plato and Chomsky said you were born with them. But how can we explain how we learn the latest concepts of science? Or how even young children understand about dinosaurs and rocket ships?

Bayesian models combine generative models and hypothesis testing with probability theory, and they address these two problems. A Bayesian model lets you calculate just how likely it is that a particular hypothesis is true, given the data. And by making small but systematic tweaks to the models we already have, and testing them against the data, we can sometimes make new concepts and models from old ones. But these advantages are offset by other problems. The Bayesian techniques can help you choose which of two hypotheses is more likely, but there are almost always an enormous number of possible hypotheses, and no system can efficiently consider them all. How do you decide which hypotheses are worth testing in the first place?

Brenden Lake at NYU and colleagues have used these kinds of top-down methods to solve another problem that's easy for people but extremely difficult for computers: recognizing unfamiliar handwritten characters. Look at a character on a Japanese scroll. Even if you've never seen it before, you can probably tell if it's similar to or different from a character on another Japanese scroll. You can probably draw it and even design a fake Japanese character based on the one you see—one that will look quite different from a Korean or Russian character. [37]

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[37] Brenden M. Lake, Ruslan Salakhutdinov & Joshua B. Tenenbaum, "Human-level concept learning through probabilistic program induction," *Science,* 350:6266, pp. 1332-38 (2015).

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The bottom-up method for recognizing handwritten characters is to give the computer thousands of examples of each one and let it pull out the salient features. Instead, Lake *et al.* gave the program a general model of how you draw a character: A stroke goes either right or left; after you finish one, you start another; and so on. When the program saw a particular character, it could infer the sequence of strokes that were most likely to have led to it—just as I inferred that the spam process led to my dubious email. Then it could judge whether a new character was likely to result from that sequence or from a different one, and it could produce a similar set of strokes itself. The program worked much better than a deep-learning program applied to exactly the same data, and it closely mirrored the performance of human beings.

These two approaches to machine learning have complementary strengths and weaknesses. In the bottom-up approach, the program doesn't need much knowledge to begin with, but it needs a great deal of data, and it can generalize only in a limited way. In the top-down approach, the program can learn from just a few examples and make much broader and more varied generalizations, but you need to build much more into it to begin with. A number of investigators are currently trying to combine the two approaches, using deep learning to implement Bayesian inference.

The recent success of AI is partly the result of extensions of those old ideas. But it has more to do with the fact that, thanks to the Internet, we have much more data, and thanks to Moore's Law we have much more computational power to apply to that data. Moreover, an unappreciated fact is that the data we do have has already been sorted and processed by human beings. The cat pictures posted to the Web are canonical cat pictures—pictures that humans have already chosen as "good" pictures. Google Translate works because it takes advantage of millions of human translations and generalizes them to a new piece of text, rather than genuinely understanding the sentences themselves.

But the truly remarkable thing about human children is that they somehow combine the best features of each approach and then go way beyond them. Over the past fifteen years, developmentalists have been exploring the way children learn structure from data. Four-year-olds can learn by taking just one or two examples of data, as a top-down system does, and generalizing to very different concepts. But they can also learn new concepts and models from the data itself, as a bottom-up system does.

For example, in our lab we give young children a "blicket detector"—a new machine to figure out, one they've never seen before. It's a box that lights up and plays music when you put certain objects on it but not others. We give children just one or two examples of how the machine works, showing them that, say, two red blocks make it go, while a green-and-yellow combination doesn't. Even eighteen-month-olds immediately figure out the general principle that the two objects have to be the same to make it go, and they generalize that principle to new examples: For instance, they will choose two objects that have the same *shape* to make the machine work. In other experiments, we've shown that children can even figure out that some hidden invisible property makes the machine go, or that the machine works on some abstract logical principle.[38]

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[38] A. Gopnik, T. Griffiths & C. Lucas, "When younger learners can be better (or at least more open-minded) than older ones," *Curr. Dir. Psychol. Sci.,* 24:2, 87-92 (2015).

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You can show this in children's everyday learning, too. Young children rapidly learn abstract intuitive theories of biology, physics, and psychology in much the way adult scientists do, even with relatively little data.

The remarkable machine-learning accomplishments of the recent AI systems, both bottom-up and top-down, take place in a narrow and well-defined space of hypotheses and concepts—a precise set of game pieces and moves, a predetermined set of images. In contrast, children and scientists alike sometimes change their concepts in radical ways, performing paradigm shifts rather than simply tweaking the concepts they already have.

Four-year-olds can immediately recognize cats and understand words, but they can also make creative and surprising new inferences that go far beyond their experience. My own grandson recently explained, for example, that if an adult wants to become a child again, he should try not eating any healthy vegetables, since healthy vegetables make a child grow into an adult. This kind of hypothesis, a plausible one that no grown-up would ever entertain, is characteristic of young children. In fact, my colleagues and I have shown systematically that preschoolers are better at coming up with unlikely hypotheses than older children and adults.[39] We have almost no idea how this kind of creative learning and innovation is possible.

Looking at what children do, though, may give programmers useful hints about directions for computer learning. Two features of children's learning are especially striking. Children are active learners; they don't just passively soak up data like AIs do. Just as scientists experiment, children are intrinsically motivated to extract information from the world around them through their endless play and exploration. Recent studies show that this exploration is more systematic than it looks and is well-adapted to find persuasive evidence to support hypothesis formation and theory choice.[40] Building curiosity into machines and allowing them to actively interact with the world might be a route to more realistic and wide-ranging learning.

Second, children, unlike existing AIs, are social and cultural learners. Humans don't learn in isolation but avail themselves of the accumulated wisdom of past generations. Recent studies show that even preschoolers learn through imitation and by listening to the testimony of others. But they don't simply passively obey their teachers. Instead they take in information from others in a remarkably subtle and sensitive way, making complex inferences about where the information comes from and how trustworthy it is and systematically integrating their own experiences with what they are hearing.[41]

"Artificial intelligence" and "machine learning" sound scary. And in some ways they are. These systems are being used to control weapons, for example, and we really should be scared about that. Still, natural stupidity can wreak far more havoc than artificial intelligence; we humans will need to be much smarter than we have been in the past to properly regulate the new technologies. But there is not much basis for either the apocalyptic or the utopian visions of AIs replacing humans. Until we solve the basic

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[39] A. Gopnik, *et al.,* "Changes in cognitive flexibility and hypothesis search across human life history from childhood to adolescence to adulthood," *Proc. Nat. Acad. Sci.,* 114:30, 7892-99 (2017).

[40] L. Schulz, "The origins of Inquiry: Inductive inference and exploration in early childhood," *Trends Cog. Sci.,* 16:7, 382-89 (2012).

[41] A. Gopnik, *The Gardener and the Carpenter* (New York: Farrar, Straus & Giroux, 2016), chaps. 4 and 5.

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paradox of learning, the best artificial intelligences will be unable to compete with the average human four-year-old.

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Peter Galison's *focus as a science historian is—speaking roughly—on the intersection of theory with experiment.*

"For quite a number of years I have been guided in my work by the odd confrontation of abstract ideas and extremely concrete objects," he once told me, in explaining how he thinks about what he does. At the Washington, Connecticut, meeting he discussed the Cold War tension between engineers (like Wiener) and the administrators of the Manhattan Project (like Oppenheimer: "When [Wiener] warns about the dangers of cybernetics, in part he's trying to compete against the kind of portentous language that people like Oppenheimer [used]: 'When I saw the explosion at Trinity, I thought of the Bhagavad Gita—I am death, destroyer of worlds.' That sense, that physics could stand and speak to the nature of the universe and airforce policy, was repellent and seductive. In a way, you can see that over and over again in the last decades—nanosciences, recombinant DNA, cybernetics: 'I stand reporting to you on the science that has the promise of salvation and the danger of annihilation—and you should pay attention, because this could kill you.' It's a very seductive narrative, and it's repeated in artificial intelligence and robotics."

As a twenty-four-year old, when I first encountered Wiener's ideas and met his colleagues at the MIT meeting I describe in the book's Introduction, I was hardly interested in Wiener's warnings or admonitions. What drove my curiosity was the stark, radical nature of his view of life, based on the mathematical theory of communications in which the message was nonlinear: According to Wiener, "new concepts of communication and control involved a new interpretation of man, of man's knowledge of the universe, and of society." And that led to my first book, which took information theory—the mathematical theory of communications—as a model for all human experience.

In a recent conversation, Peter told me he was beginning to write a book—about building, crashing, and thinking—that considers the black-box nature of cybernetics and how it represents what he thinks of as "the fundamental transformation of learning, machine learning, cybernetics, and the self."

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ALGORISTS DREAM OF OBJECTIVITY
Peter Galison

Peter Galison *is a science historian, Joseph Pellegrino University Professor and co-founder of the Black Hole Initiative at Harvard University, and the author of* Einstein's Clocks and Poincaré's Maps: Empires of Time.

In his second-best book, the great medieval mathematician al-Khwarizmi described the new place-based Indian form of arithmetic. His name, soon sonically linked to "algorismus" (in late medieval Latin) came to designate procedures acting upon numbers—eventually wending its way through "algorithm," (on the model of "logarithm"), into French and on into English. But I like the idea of a modern algorist, even if my spellcheck does not. I mean by it someone profoundly suspicious of the intervention of human judgment, someone who takes that judgment to violate the fundamental norms of what it is to be objective (and therefore scientific).

Near the end of the 20th century, a paper by two University of Minnesota psychologists summarized a vast literature that had long roiled the waters of prediction. One side, they judged, had for all too long held resolutely—and ultimately unethically—to the "clinical method" of prediction, which prized all that was *subjective*: "informal," "in-the-head," and "impressionistic." These clinicians were people (so said the psychologists) who thought they could study their subjects with meticulous care, gather in committees, and make judgment-based predictions about criminal recidivism, college success, medical outcomes, and the like. The other side, the psychologists continued, embodied everything the clinicians did not, embracing the *objective*: "formal," "mechanical," "algorithmic." This the authors took to stand at the root of the whole triumph of post-Galilean science. Not only did science benefit from the actuarial; to a great extent, science *was* the mechanical-actuarial. Breezing through 136 studies of predictions, across domains from sentencing to psychiatry, the authors showed that in 128 of them, predictions using actuarial tables, a multiple-regression equation, or an algorithmic judgment equalled or exceeded in accuracy those using the subjective approach.

They went on to catalog seventeen fallacious justifications for clinging to the clinical. There were the self-interested foot-draggers who feared losing their jobs to machines. Others lacked the education to follow statistical arguments. One group mistrusted the formalization of mathematics; another excoriated what they took to be the actuarial "dehumanizing;" yet others said that the aim was to understand, not to predict. But whatever the motivations, the review concluded that it was downright immoral to withhold the power of the objective over the subjective, the algorithmic over expert judgment.[42]

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[42] William M. Grove & Paul E. Meehl, "Comparative efficiency of informal (subjective, impressionistic) and formal (mechanical, algorithmic) prediction procedures: The Clinical-Statistical Controversy," *Psychology, Public Policy, and Law*, 2:2, 293-323 (1996).

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The algorist view has gained strength. Anne Milgram served as Attorney General of the State of New Jersey from 2007 to 2010. When she took office, she wanted to know who the state was arresting, charging, and jailing, and for what crimes. At the time, she reports in a later TED Talk, she could find almost no data or analytics. By imposing statistical prediction, she continues, law enforcement in Camden during her tenure was able to reduce murders by 41 percent, saving thirty-seven lives, while dropping the total crime rate by 26 percent. After joining the Arnold Foundation as its vice president for criminal justice, she established a team of data scientists and statisticians to create a risk-assessment tool; fundamentally, she construed the team's mission as deciding how to put "dangerous people" in jail while releasing the non-dangerous. "The reason for this," Milgram contended, "is the way we make decisions. Judges have the best intentions when they make these decisions about risk, but they're making them subjectively. They're like the baseball scouts twenty years ago who were using their instinct and their experience to try to decide what risk someone poses. They're being subjective, and we know what happens with subjective decision making, which is that we are often wrong." Her team established nine-hundred-plus risk factors, of which nine were most predictive. The questions, the most urgent questions, for the team were: Will a person commit a new crime? Will that person commit a violent act? Will someone come back to court? We need, concluded Milgram, an "objective measure of risk" that should be inflected by judges' judgment. We know the algorithmic statistical process works. That, she says, is "why Google is Google" and why moneyball wins games.[43]

Algorists have triumphed. We have grown accustomed to the idea that protocols and data can and should guide us in everyday action, from reminders about where we probably want to go next, to the likely occurrence of crime. By now, according to the literature, the legal, ethical, formal, and economic dimensions of algorithms are all quasi-infinite. I'd like to focus on one particular siren song of the algorithm: its promise of objectivity.

Scientific objectivity has a history. That might seem surprising. Isn't the notion—expressed above by the Minnesota psychologists—right? Isn't objectivity co-extensive with science itself? Here it's worth stepping back to reflect on all the epistemic virtues we might value in scientific work. Quantification seems like a good thing to have; so, too, do prediction, explanation, unification, precision, accuracy, certainty, and pedagogical utility. In the best of all possible worlds these epistemic virtues would all pull in the same direction. But they do not—not any more than our ethical virtues necessarily coincide. Rewarding people according to their need may very well conflict with rewarding people according to their ability. Equality, fairness, meritocracy—ethics, in a sense, is all about the adjudication of conflicting goods. Too often we forget that this conflict exists in science, too. Design an instrument to be as sensitive as possible and it often fluctuates wildly, making repetition of a measurement impossible.

"Scientific objectivity" entered both the practice and the nomenclature of science after the first third of the 19th century. One sees this clearly in the scientific atlases that provided scientists with the basic objects of their specialty: There were (and are) atlases of the hand, atlases of the skull, atlases of clouds, crystals, flowers, bubble-chamber pictures, nuclear emulsions, and diseases of the eye. In the 18th century, it was obvious

[43] TED Talk, January 2014, https://www.ted.com/speakers/anne_milgram.

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that you would not depict this particular, sun-scorched, caterpillar-chewed clover found outside your house in an atlas. No, you aimed—if you were a genius natural philosopher like Goethe, Albinus, or Cheselden—to observe nature but then to perfect the object in question, to abstract it visually to the ideal. Take a skeleton, view it through a camera lucida, draw it with care. Then correct the "imperfections." The advantage of this parting of the curtains of mere experience was clear: It provided a universal guide, one not attached to the vagaries of individual variation.

As the sciences grew in scope, and scientists grew in number, the downside of idealization became clearer. It was one thing to have Goethe depict the "ur-plant" or "ur-insect." It was quite another to have a myriad of different scientists each fixing their images in different and sometimes contradictory ways. Gradually, from around the 1830s forward, one begins to see something new: a claim that the image making was done with a minimum of human intervention, that protocols were followed. This could mean tracing a leaf with a pencil or pressing it into ink that was transferred to the page. It meant, too, that one suddenly was proud of depicting the view through a microscope of a natural object even with its imperfections. This was a radical idea: snowflakes shown without perfect hexagonal symmetry, color distortion near the edge of a microscope lens, tissue torn around the edges in the process of its preparation.

Scientific objectivity came to mean that our representations of things were executed by holding back from intervention—even if it meant reproducing the yellow color near the edge of the image under the microscope, despite the fact that the scientist *knew* that the discoloration was from the lens, not a feature of the object of inquiry. The advantage of objectivity was clear: It superseded the desire to see a theory realized or a generally accepted view confirmed. But objectivity came at a cost. You lost that precise, easily teachable, colored, full depth-of-field, artist's rendition of a dissected corpse. You got a blurry, bad depth-of-field, black-and-white photograph that no medical student (nor even many medical colleagues) could use to learn and compare cases. Still, for a long stretch of the 19th century, the virtue of hands-off, self-restraining objectivity was on the rise.

Starting in the 1930s, the hardline scientific objectivity in scientific representation began running into trouble. In cataloging stellar spectra, for example, no algorithm could compete with highly trained observers who could sort them with far greater accuracy and replicability than any purely rule-following procedure. By the late 1940s, doctors had begun learning how to read electroencephalograms. Expert judgment was needed to sort out different kinds of seizure readings, while none of the early attempts to use frequency analysis could match that judgment. Solar magnetograms—mapping the magnetic fields across the sun—required the trained expert to pry the real signal from artifacts that emerged from the measuring instruments. Even particle physicists recognized that they could not program a computer to sort certain kinds of tracks into the right bins; judgment, trained judgment, was needed.

There should be no confusion here: This was not a return to the invoked genius of an 18th-century idealizer. No one thought you could train to be a Goethe who alone among scientists could pick out the universal, ideal form of a plant, insect, or cloud. Expertise could be learned—you could take a course to learn to make expert judgments about electroencephalograms, stellar spectra, or bubble-chamber tracks; alas, no one has ever thought you could take a course that would lead to the mastery of exceptional

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insight. There can be no royal road to becoming Goethe. In scientific atlas after scientific atlas, one sees explicit argument that "subjective" factors had to be part of the scientific work needed to create, classify, and interpret scientific images.

What we see in so many of the algorists' claims is a tremendous desire to find scientific objectivity precisely by abandoning judgment and relying on mechanical procedures—in the name of scientific objectivity. Many American states have legislated the use of sentencing and parole algorithms. Better a machine, it is argued, than the vagaries of a judge's judgment.

So here is a warning from the sciences. Hands-off algorithmic proceduralism did indeed have its heyday in the 19th century, and of course still plays a role in many of the most successful technical and scientific endeavors. But the idea that mechanical objectivity, construed as binding self-restraint, follows a simple, monotonic curve increasing from the bad impressionistic clinician to the good externalized actuary simply does not answer to the more interesting and nuanced history of the sciences.

There is a more important lesson from the sciences. Mechanical objectivity is a scientific virtue among others, and the hard sciences learned that lesson often. We must do the same in the legal and social scientific domains. What happens, for example, when the secret, proprietary algorithm sends one person to prison for ten years and another for five years, for the same crime? Rebecca Wexler, visiting fellow at the Yale Law School Information Society Project, has explored that question, and the tremendous cost that trade-secret algorithms impose on the possibility of a fair legal defense.[44] Indeed, for a variety of reasons, law enforcement may not want to share the algorithms used to make DNA, chemical, or fingerprint identifications, which puts the defense in a much weakened position to make its case. In the courtroom, objectivity, trade secrets, and judicial transparency may pull in opposite directions. It reminds me of a moment in the history of physics. Just after World War II, the film giants Kodak and Ilford perfected a film that could be used to reveal the interactions and decays of elementary particles. The physicists were thrilled, of course—until the film companies told them that the composition of the film was a trade secret, so the scientists would never gain complete confidence that they understood the processes they were studying. Proving things with unopenable black boxes can be a dangerous game for scientists, and doubly so for criminal justice.

Other critics have underscored how perilous it is to rely on an accused (or convicted) person's address or other variables that can easily become, inside the black box of algorithmic sentencing, a proxy for race. By dint of everyday experience, we have grown used to the fact that airport security is different for children under the age of twelve and adults over the age of seventy-five. What factors do we want the algorists to have in their often hidden procedures? Education? Income? Employment history? What one has read, watched, visited, or bought? Prior contact with law enforcement? How do we want algorists to weight those factors? Predictive analytics predicated on mechanical objectivity comes at a price. Sometimes it may be a price worth paying; sometimes that price would be devastating for the just society we want to have.

More generally, as the convergence of algorithms and Big Data governs a greater and greater part of our lives, it would be well worth keeping in mind these two lessons

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[44] Rebecca Wexler, "Life, Liberty, and Trade Secrets: Intellectual Property in the Criminal Justice System," 70 *Stanford Law Review*, XXX (2018).

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from the history of the sciences: Judgment is not the discarded husk of a now pure objectivity of self-restraint. And mechanical objectivity is a virtue competing among others, not the defining essence of the scientific enterprise. They are lessons to bear in mind, even if algorists dream of objectivity.

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In the past decade, genetic engineering has caught up with computer science with regard to how new scientific initiatives are shaping our lives. Genetic engineer **George Church**, *a pioneer of the revolution in reading and writing biology, is central to this new landscape of ideas. He thinks of the body as an operating system, with engineers taking the place of traditional biologists in retooling stripped-down components of organisms (from atoms to organs) in much the same vein as in the late 1970s, when electrical engineers were working their way to the first personal computer by assembling circuit boards, hard drives, monitors, etc. George created and is director of the Personal Genome Project, which provides the world's only open-access information on human genomic, environmental, and trait data (GET) and sparked the growing DNA ancestry industry.*

He was instrumental in laying the groundwork for President Obama's 2013 BRAIN (Brain Research through Advancing Innovative Neurotechnologies) Initiative—in aid of improving the brains of human beings to the point where, for much of what sustains us, we might not need the help of (potentially dicey) AIs. "It could be that some of the BRAIN Initiative projects allow us to build human brains that are more consistent with our ethics and capable of doing advanced tasks like artificial intelligence," George has said. "The safest path by far is getting humans to do all the tasks that they would like to delegate to machines, but we're not yet firmly on that super-safe path."

More recently, his crucially important pioneering use of the enzyme CRISPR (as well as methods better than CRISPR) to edit the genes of human cells is sometimes missed by the media in the telling of the CRISPR origins story.

George's attitude toward future forms of artificial general intelligence is friendly, as evinced in the essay that follows. At the same time, he never loses sight of the AI-safety issue. On that subject, he recently remarked: "The main risk in AI, to my mind, is not so much whether we can mathematically understand what they're thinking; it's whether we're capable of teaching them ethical behavior. We're barely capable of teaching each other ethical behavior."

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THE RIGHTS OF MACHINES
George M. Church

***George M. Church** is Robert Winthrop Professor of Genetics at Harvard Medical School; Professor of Health Sciences and Technology, Harvard-MIT; and co-author (with Ed Regis) of* Regenesis: How Synthetic Biology Will Reinvent Nature and Ourselves.

In 1950, Norbert Wiener's *The Human Use of Human Beings* was at the cutting edge of vision and speculation in proclaiming that

> the machine like the djinnee, which can learn and can make decisions on the basis of its learning, will in no way be obliged to make such decisions as we should have made, or will be acceptable to us. . . . Whether we entrust our decisions to machines of metal, or to those machines of flesh and blood which are bureaus and vast laboratories and armies and corporations, . . . [t]he hour is very late, and the choice of good and evil knocks at our door.

But this was his book's denouement, and it has left us hanging now for sixty-eight years, lacking not only prescriptions and proscriptions but even a well-articulated "problem statement." We have since seen similar warnings about the threat of our machines, even in the form of outreach to the masses, via films like *Colossus: The Forbin Project* (1970), *The Terminator* (1984), *The Matrix* (1999), and *Ex Machina* (2015). But now the time is ripe for a major update, with fresh, new perspectives—notably focused on generalizations of our "human" rights and our existential needs.

Concern has tended to focus on "us versus them [robots]" or "grey goo [nanotech]" or "monocultures of clones [bio]." To extrapolate current trends: What if we could make or grow almost anything and engineer any level of safety and efficacy desired? Any thinking being (made of any arrangement of atoms) could have access to any technology.

Probably we should be less concerned about us-versus-them and more concerned about the rights of all sentients in the face of an emerging unprecedented diversity of minds. We should be harnessing this diversity to minimize global existential risks, like supervolcanoes and asteroids.

But should we say "should"? (Disclaimer: In this and many other cases, when a technologist describes a societal path that "could," "would," or "should" happen, this doesn't necessarily equate to the preferences of the author. It could reflect warning, uncertainty, and/or detached assessment.) Roboticist Gianmarco Veruggio and others have raised issues of roboethics since 2002; the U.K. Department of Trade and Industry and the RAND spin-off Institute for the Future have raised issues of robot rights since 2006.

"Is versus ought"

It is commonplace to say that science concerns "is," not "ought." Stephen Jay Gould's "non-overlapping magisteria" view argues that facts must be completely distinct from values. Similarly, the 1999 document *Science and Creationism* from the U.S. National Academy of Sciences noted that "science and religion occupy two separate realms." This

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division has been critiqued by evolutionary biologist Richard Dawkins, myself, and others. We can discuss "should" if framed as "we should do X in order to achieve Y." Which Y should be a high priority is not necessarily settled by democratic vote but might be settled by Darwinian vote. Value systems and religions wax and wane, diversify, diverge, and merge just as living species do: subject to selection. The ultimate "value" (the "should") is survival of genes and memes.

Few religions say that there is no connection between our physical being and the spiritual world. Miracles are documented. Conflicts between Church doctrine and Galileo and Darwin are eventually resolved. Faith and ethics are widespread in our species and can be studied using scientific methods, including but not limited to fMRI, psychoactive drugs, questionnaires, et cetera.

Very practically, we have to address the ethical rules that should be built in, learned, or probabilistically chosen for increasingly intelligent and diverse machines. We have a whole series of trolley problems. At what number of people in line for death should the computer decide to shift a moving trolley to one person? Ultimately this might be a deep-learning problem—one in which huge databases of facts and contingencies can be taken into account, some seemingly far from the ethics at hand.

For example, the computer might infer that the person who would escape death if the trolley is left alone is a convicted terrorist recidivist loaded up with doomsday pathogens, or a saintly POTUS—or part of a much more elaborate chain of events in detailed alternative realities. If one of these problem descriptions seems paradoxical or illogical, it may be that the authors of the trolley problem have adjusted the weights on each sides of the balance such that hesitant indecision is inevitable.

Alternatively, one can use misdirection to rig the system, such that the error modes are not at the level of attention. For example, in the Trolley Problem, the real ethical decision was made years earlier when pedestrians were given access to the rails—or even before that, when we voted to spend more on entertainment than on public safety. Questions that at first seem alien and troubling, like "Who owns the new minds, and who pays for their mistakes?" are similar to well-established laws about who owns and pays for the sins of a corporation.

The Slippery Slopes

We can (over)simplify ethics by claiming that certain scenarios won't happen. The technical challenges or the bright red lines that cannot be crossed are reassuring, but the reality is that once the benefits seem to outweigh the risks (even briefly and barely), the red lines shift. Just before Louise Brown's birth in 1978, many people were worried that she "would turn out to be a little monster, in some way, shape or form, deformed, something wrong with her."[45] Few would hold this view of in-vitro fertilization today.

What technologies are lubricating the slope toward multiplex sentience? It is not merely deep machine-learning algorithms with Big Iron. We have engineered rodents to be significantly better at a variety of cognitive tasks as well as to exhibit other relevant traits, such as persistence and low anxiety. Will this be applicable to animals that are already at the door of humanlike intelligence? Several show self-recognition in a mirror test—chimpanzees, bonobos, orangutans, some dolphins and whales, and magpies.

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[45] "Then, Doctors 'All Anxious' About Test-tube Baby" http://edition.cnn.com/2003/HEALTH/parenting/07/25/cnna.copperman/

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Even the bright red line for human manipulation of human beings shows many signs of moving or breaking completely. More than 2,300 approved clinical trials for gene therapy are in progress worldwide. A major medical goal is the treatment or prevention of cognitive decline, especially in light of our rapidly aging global demographic. Some treatments of cognitive decline will include cognitive enhancements (drugs, genes, cells, transplants, implants, and so on). These will be used off-label. The rules of athletic competition (e.g., banning augmentation with steroids or erythropoietin) do not apply to intellectual competition in the real world. Every bit of progress on cognitive decline is in play for off-label use.

Another frontier of the human use of humans is "brain organoids." We can now accelerate developmental biology. Processes that normally take months can happen in four days in the lab using the right recipes of transcription factors. We can make brains that, with increasing fidelity, recapitulate the differences between people born with aberrant cognitive abilities (e.g., microcephaly). Proper vasculature (veins, arteries, and capillaries) missing from earlier successes are now added, enabling brain organoids to surpass the former sub-microliter limit to possibly exceed the 1.2-liter size of modern human brains (or even the 5-liter elephant or 8-liter sperm whale brains).

Conventional Computers versus Bio-electronic Hybrids

As Moore's Law miniaturization approaches its next speed bump (surely not a solid wall), we see the limits of the stochastics of dopant atoms in silicon slabs and the limits of beam-fabrication methods at around 10-nanometer feature size. Power (energy consumption) issues are also apparent: The great Watson, winner of *Jeopardy!*, used 85,000 watts real time, while the human brains were using 20 watts each. To be fair, the human body needs 100 watts to operate and twenty years to build, hence about 6 trillion joules of energy to "manufacture" a mature human brain. The cost of manufacturing Watson-scale computing is similar. So why aren't humans displacing computers?

For one, the *Jeopardy!* contestants' brains were doing far more than information retrieval—much of which would be considered mere distractions by Watson (e.g., cerebellar control of smiling). Other parts allow leaping out of the box with transcendence unfathomable by Watson, such as what we see in Einstein's five *annus mirabilis* papers of 1905. Also, humans consume more energy than the minimum (100 W) required for life and reproduction. People in India use an average of 700 W per person; it's 10,000 W in the U.S. Both are still less than the 85,000 watts Watson uses. Computers can become more like us via neuromorphic computing, possibly a thousandfold. But human brains could get more efficient, too. The organoid brain-in-a-bottle could get closer to the 20 W limit. The idiosyncratic advantages of computers for math, storage, and search, faculties of limited use to our ancestors, could be designed and evolved anew in labs.

Facebook, the National Security Agency, and others are constructing exabyte-scale storage facilities at more than a megawatt and four hectares, while DNA can store that amount in a milligram. Clearly, DNA is not a mature storage technology, but with Microsoft and Technicolor doubling down on it, we would be wise to pay attention. The main reason for the 6 trillion joules of energy required to get a productive human mind is the twenty years required for training.

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Even though a supercomputer can "train" a clone of zemself in seconds, the energy cost of producing a mature silicon clone is comparable. Engineering (*Homo*) prodigies might make a small impact on this slow process, but speeding up development and implanting extensive memory (as DNA-exabytes or other means) could reduce duplication time of a bio-computer to close to the doubling time of cells (ranging from eleven minutes to twenty-four hours). The point is that while we may not know what ratio of bio/homo/nano/robo hybrids will be dominant at each step of our accelerating evolution, we can aim for high levels of humane, fair, and safe treatment ("use") of one another.

Bills of Rights date back to 1689 in England. FDR proclaimed the "Four Freedoms"—freedom of speech, freedom of conscience, freedom from fear, and freedom from want. The U.N.'s Universal Declaration of Human Rights in 1948 included the right to life; the prohibition of slavery; defense of rights when violated; freedom of movement; freedom of association, thought, conscience, and religion; social, economic, and cultural rights; duties of the individual to society; and prohibition of use of rights in contravention of the purposes and principles of the United Nations.

The "universal" nature of these rights is not universally embraced and is subject to extensive critique and noncompliance. How does the emergence of non-*Homo*-intelligences affect this discussion? At a minimum, it is becoming rapidly difficult to hide behind vague intuition for ethical decisions—"I know it when I see it" (U.S. Supreme Court Justice Potter Stewart, 1964) or the "wisdom of repugnance" (aka "yuck factor," Leon Kass, 1997), or vague appeals to "common sense." As we have to deal with minds alien to us, sometimes quite literal from our viewpoint, we need to be explicit—yea, even algorithmic.

Self-driving cars, drones, stock-market transactions, NSA searches, et cetera, require rapid, pre-approved decision making. We may gain insights into many aspects of ethics that we have been trying to pin down and explain for centuries. The challenges have included conflicting priorities, as well as engrained biological, sociological, and semi-logical cognitive biases. Notably far from consensus in universal dogmas about human rights are notions of privacy and dignity, even though these influence many laws and guidelines.

Humans might want the right to march in to read (and change) the minds of computers to see why they're making decisions at odds with our (*Homo*) instincts. Is it not fair for machines to ask the same of us? We note the growth of movements toward transparency in potential financial conflicts; "open-source" software, hardware, and wetware; the Fair Access to Science and Technology Research Act (FASTR); and the Open Humans Foundation.

In his 1976 book *Computer Power and Human Reason,* Joseph Weizenbaum argued that machines should not replace *Homo* in situations requiring respect, dignity, or care, while others (author Pamela McCorduck and computer scientists like John McCarthy and Bill Hibbard) replied that machines can be more impartial, calm, and consistent and less abusive or mischievous than people in such positions.

Equality

What did the thirty-three-year-old Thomas Jefferson mean in 1776 when he wrote, "We hold these Truths to be self-evident, that all Men are created equal, that they are endowed

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by their Creator with certain unalienable Rights, that among these are Life, Liberty, and the Pursuit of Happiness"? The spectrum of current humans is vast. In 1776, "Men" did not include people of color or women. Even today, humans born with congenital cognitive or behavioral issues are destined for unequal (albeit in most cases compassionate) treatment—Down syndrome, Tay-Sachs disease, Fragile X syndrome, cerebral palsy, and so on.

And as we change geographical location and mature, our unequal rights change dramatically. Embryos, infants, children, teens, adults, patients, felons, gender identities and gender preferences, the very rich and very poor—all of these face different rights and socioeconomic realities. One path to new mind-types obtaining and retaining rights similar to the most elite humans would be to keep a *Homo* component, like a human shield or figurehead monarch/CEO, signing blindly enormous technical documents, making snap financial, health, diplomatic, military, or security decisions. We will probably have great difficulty pulling the plug, modifying, or erasing (killing) a computer and its memories—especially if it has befriended humans and made spectacularly compelling pleas for survival (as all excellent researchers fighting for their lives would do).

Even Scott Adams, creator of *Dilbert*, has weighed in on this topic, supported by experiments at Eindhoven University in 2005 noting how susceptible humans are to a robot-as-victim equivalent of the Milgram experiments done at Yale beginning in 1961. Given the many rights of corporations, including ownership of property, it seems likely that other machines will obtain similar rights, and it will be a struggle to maintain inequities of selective rights along multi-axis gradients of intellect and ersatz feelings.

Radically Divergent Rules for Humans versus Nonhumans and Hybrids

The divide noted above for intra *Homo sapiens* variation in rights explodes into a riot of inequality as soon as we move to entities that overlap (or will soon) the spectrum of humanity. In Google Street View, people's faces and car license plates are blurred out. Video devices are excluded from many settings, such as courts and committee meetings. Wearable and public cameras with facial-recognition software touch taboos. Should people with hyperthymesia or photographic memories be excluded from those same settings?

Shouldn't people with prosopagnosia (face blindness) or forgetfulness be able to benefit from facial-recognition software and optical character recognition wherever they go, and if them, then why not everyone? If we all have those tools to some extent, shouldn't we all be able to benefit?

These scenarios echo Kurt Vonnegut's 1961 short story "Harrison Bergeron," in which exceptional aptitude is suppressed in deference to the mediocre lowest common denominator of society. Thought experiments like John Searle's Chinese Room and Isaac Asimov's Three Laws of Robotics all appeal to the sorts of intuitions plaguing human brains that Daniel Kahneman, Amos Tversky, and others have demonstrated. The Chinese Room experiment posits that a mind composed of mechanical and *Homo sapiens* parts cannot be conscious, no matter how competent at intelligent human (Chinese) conversation, unless a human can identify the source of the consciousness and "feel" it. Enforced preference for Asimov's First and Second Laws favor human minds over any other mind meekly present in his Third Law, of self-preservation.

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If robots don't have exactly the same consciousness as humans, then this is used as an excuse to give them different rights, analogous to arguments that other tribes or races are less than human. Do robots already show free will? Are they already self-conscious? The robots Qbo have passed the "mirror test" for self-recognition and the robots NAO have passed a related test of recognizing their own voice and inferring their internal state of being, mute or not.

For free will, we have algorithms that are neither fully deterministic nor random but aimed at nearly optimal probabilistic decision making. One could argue that this is a practical Darwinian consequence of game theory. For many (not all) games/problems, if we're totally predictable or totally random, then we tend to lose.

What is the appeal of free will anyway? Historically it gave us a way to assign blame in the context of reward and punishment on Earth or in the afterlife. The goals of punishment might include nudging the priorities of the individual to assist the survival of the species. In extreme cases, this could include imprisonment or other restrictions, if Skinnerian positive/negative reinforcement is inadequate to protect society. Clearly, such tools can apply to free will, seen broadly—to any machine whose behavior we'd like to manage.

We could argue as to whether the robot actually experiences subjective qualia for free will or self-consciousness, but the same applies to evaluating a human. How do we know that a sociopath, a coma patient, a person with Williams syndrome, or a baby has the same free will or self-consciousness as our own? And what does it matter, practically? If humans (of any sort) convincingly claim to experience consciousness, pain, faith, happiness, ambition, and/or utility to society, should we deny them rights because their hypothetical qualia are hypothetically different from ours?

The sharp red lines of prohibition, over which we supposedly will never step, increasingly seem to be short-lived and not sensible. The line between human and machines blurs, both because machines become more humanlike and humans become more machine-like—not only since we increasingly blindly follow GPS scripts, reflex tweets, and carefully crafted marketing, but also as we digest ever more insights into our brain and genetic programming mechanisms. The NIH BRAIN Initiative is developing innovative technologies and using these to map out the connections and activity of mental circuitry so as to improve electronic and synthetic neurobiological ware.

Various red lines depend on genetic exceptionalism, in which genetics is considered permanently heritable (although it is provably reversible), whereas exempt (and lethal) technologies, like cars, are for all intents and purposes irreversible due to social and economic forces. Within genetics, a red line makes us ban or avoid genetically modified foods but embrace genetically modified bacteria making insulin, or genetically modified humans—witness mitochondrial therapies approved in Europe for human adults and embryos.

The line for germline manipulation seems less sensible than the usual, practical line drawn at safety and efficacy. Marriages of two healthy carriers of the same genetic disease have a choice between no child of their own, 25-percent loss of embryos via abortion (spontaneous or induced), 80-percent loss via in-vitro fertilization, or potential zero-percent embryo loss via sperm (germline) engineering. It seems premature to declare this last option unlikely.

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For "human subject research," we refer to the 1964 Declaration of Helsinki, keeping in mind the 1932-1972 Tuskegee syphilis experiment, possibly the most infamous biomedical research study in U.S. history. In 2015, the Nonhuman Rights Project filed a lawsuit with the New York State Supreme Court on behalf of two chimpanzees kept for research by Stony Brook University. The appellate court decision was that chimps are not to be treated as legal persons since they "do not have duties and responsibilities in society," despite Jane Goodall's and others' claim that they do, and despite arguments that such a decision could be applied to children and the disabled.[46]

What prevents extension to other animals, organoids, machines, and hybrids? As we (e.g., Hawking, Musk, Tallinn, Wilczek, Tegmark) have promoted bans on "autonomous weapons," we have demonized one type of "dumb" machine, while other machines—for instance, those composed of many *Homo sapiens* voting—can be more lethal and more misguided.

Do transhumans roam the Earth already? Consider the "uncontacted peoples," such as the Sentinelese and Andamanese of India, the Korowai of Indonesia, the Mashco-Piro of Peru, the Pintupi of Australia, the Surma of Ethiopia, the Ruc of Vietnam, the Ayoreo-Totobiegosode of Paraguay, the Himba of Namibia, and dozens of tribes in Papua New Guinea. How would they or our ancestors respond? We could define "transhuman" as people and culture not comprehensible to humans living in a modern, yet un-technological culture.

Such modern Stone Age people would have great trouble understanding why we celebrate the recent LIGO gravity-wave evidence supporting the hundred-year-old general theory of relativity. They would scratch their heads as to why we have atomic clocks, or GPS satellites so we can find our way home, or why and how we have expanded our vision from a narrow optical band to the full spectrum from radio to gamma. We can move faster than any other living species; indeed, we can reach escape velocity from Earth and survive in the very cold vacuum of space.

If those characteristics (and hundreds more) don't constitute transhumanism, then what would? If we feel that the judge of transhumanism should not be fully paleo-culture humans but recent humans, then how would we ever reach transhuman status? We "recent humans" may always be capable of comprehending each new technological increment—never adequately surprised to declare arrival at a (moving) transhuman target. The science-fiction prophet William Gibson said, "The future is already here—it's just not very evenly distributed." While this underestimates the next round of "future," certainly millions of us are transhuman already—with most of us asking for more. The question "What was a human?" has already transmogrified into "What were the many kinds of transhumans?. . . And what were their rights?"

[46] https://www.nbcnews.com/news/us-news/lawyer-denying-chimpanzees-rights-could-backfire-disabled-n734566.

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Caroline A. Jones' *interest in modern and contemporary art is enriched by a willingness to delve into the technologies involved in its production, distribution, and reception. "As an art historian, a lot of my questions are about what kind of art we can make, what kind of thought we can make, what kind of ideas we can make that could stretch the human beyond our stubborn, selfish, 'only concerned with our small group' parameters. The philosophers and philosophies I'm drawn to are those that question the Western obsession with individualism. Those are coming from so many different places, and they're reviving so many different kinds of questions and problems that were raised in the 1960s."*

She has recently turned her attention to the history of cybernetics. Her MIT course, "Automata, Automatism, Systems, Cybernetics," explores the history of the human/machine interface in terms of feedback, exploring the cultural rather than engineering uptake of this idea. She begins with primary readings by Wiener, Shannon, and Turing and then pivots from the scientists and engineers to the work and ideas of artists, feminists, postmodern theorists. Her goal: to come up with a new central paradigm of evolution that's culture-based—"communalism and interspecies symbiosis rather than survival of the fittest."

As a historian, Caroline draws a distinction between what she has termed "left cybernetics" and "right cybernetics": "What do I mean by left cybernetics? In one sense, it's a pun or a joke: the cybernetics that was 'left' behind. On another level, it's a vague political grouping connoting our Left Coast: California, Esalen, the group that Dave Kaiser calls the 'hippie physicists.' It's not an adequate term, but it's a way of recognizing that there was a group beholden to the military-industrial complex, sometimes very unhappily, who gave us the tools to critique it."

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THE ARTISTIC USE OF CYBERNETIC BEINGS

Caroline A. Jones

Caroline A. Jones *is a professor of art history in the Department of Architecture at MIT and author of* Eyesight Alone: Clement Greenberg's Modernism and the Bureaucratization of the Senses; Machine in the Studio: Constructing the Postwar American Artist; *and* The Global Work of Art.

> Cybernated art is very important, but art for cybernated life is more important.
> — *Nam June Paik, 1966*

Artificial intelligence was not what artists first wanted out of cybernetics, once Norbert Wiener's *The Human Use of Human Beings: Cybernetics and Society* came out in 1950. The range of artists who identified themselves with cybernetics in the fifties and sixties initially had little access to "thinking machines." Moreover, craft-minded engineers had already been making turtles, jugglers, and light-seeking robot babes, not giant brains. Using breadboards, copper wire, simple switches, and electronic sensors, artists followed cyberneticians in making sculptures and environments that simulated interactive sentience—analog movements and interfaces that had more to do with instinctive drives and postwar sexual politics than the automation of knowledge production. Now obscured by an ideology of a free-floating "intelligence" untethered by either hardware or flesh, AI has forgotten the early days of cybernetics' uptake by artists. Those efforts are worth revisiting; they modeled relations with what the French philosophers Gilles Deleuze and Félix Guattari have called the "machinic phylum," having to do with how humans think and feel in bodies engaged with a physical, material, emotionally stimulating, and signaling world.

Cybernetics now seems to have collapsed into an all-pervasive discourse of AI that was far from preordained. "Cybernetics," as a word, claimed postwar newness for concepts that were easily four centuries old: notions of feedback, machine damping, biological homeostasis, logical calculation, and systems thinking that had been around since the Enlightenment (boosted by the Industrial Revolution). The names in this lineage include Descartes, Leibniz, Sadi Carnot, Clausius, Maxwell, and Watt. Wiener's coinage nonetheless had profound cultural effects.[47] The ubiquity today of the prefix "cyber-" confirms the desire for a crisp signifier of the tangled relations between humans and machines. In Wiener's usage, things "cyber" simply involved "control and communication in the animal and the machine." But after the digital revolution, "cyber" moved beyond servomechanisms, feedback loops, and switches to encompass software, algorithms, and cyborgs. The work of cybernetically inclined artists concerns the emergent behaviors of life that elude AI in its current condition.

As to that original coinage, Wiener had reached back to the ancient Greek to borrow the word for "steersman" (κυβερνήτης / *kubernétés*), a masculine figure channeling power and instinct at the helm of a ship, who read the waves, judged the wind, kept a hand on the tiller, and directed the slaves as they mindlessly (mechanically) churned their oars. The Greek had already migrated into modern English via Latin, going

[47] Wiener later had to admit the earlier coinage of the word in 1834 by André-Marie Ampère, who had intended it to mean the "science of government," a concept that remained dormant until the 20th century.

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from *kuber-* to *guber*—the root of "gubernatorial" and "governor," another term for masculine control, deployed by James Watt to describe his 19th-century device for modulating a runaway steam engine. Cybernetics thus took ideas that had long analogized people and devices and generalized them to an applied science by adding that "-ics." Wiener's three c's (command, control, communication) drew on the mathematics of probability to formalize systems (whether biological or mechanical) theorized as a set of inputs of information achieving outputs of actions in an environment—a muscular, fleshy agenda often minimized in genealogies of AI.

But the etymology does little to capture the excitement felt by participants, as mathematics joined theoretical biology (Arturo Rosenblueth) and information theory (Claude Shannon, Walter Pitts, Warren McCulloch) to produce a barrage of interdisciplinary research and publications viewed as changing not just the way science was done but the way future humans would engage with the technosphere. As Wiener put it, "We have modified our environment so radically that we must now modify ourselves in order to exist."[48] The pressing question is: How are we modifying ourselves? Are we going in the right direction or have we lost our way, becoming the tools of our tools? Revisiting the early history of humanist/artists' contribution to cybernetics may help direct us toward a less perilous, more ethical future.

The year 1968 was a high-water mark of the cultural diffusion and artistic uptake of the term. In that year, the Howard Wise gallery opened its show of Wen-Ying Tsai's "Cybernetic Sculpture" in midtown Manhattan, and Polish émigré Jasia Reichardt opened her exhibition "Cybernetic Serendipity" at London's ICA. (The "Cybernetic" in her title was intended to evoke "made by or with computers," even though most of the artworks on view had no computers, as such, in their responsive circuits.) The two decades between 1948 and 1968 had seen both the fanning out of cybernetic concepts into a broader culture and the spread of computation machines themselves in a slow migration from proprietary military equipment, through the multinational corporation, to the academic lab, where access began to be granted to artists. The availability of cybernetic components—"sensor organs" (electronic eyes, motion sensors, microphones) and "effector organs" (electronic "breadboards," switches, hydraulics, pneumatics)—on the home hobbyist front rendered the computer less an "electronic brain" than an adjunct organ in a kit of parts. There was not yet a ruling metaphor of "artificial intelligence." So artists were bricoleurs of electronic bodies, interested in actions rather than calculation or cognition. There were inklings of "computer" as calculator in the drive toward *Homo rationalis*, but more in aspiration than achievement.

In light of today's digital convergence in art/science imaging tools, Reichardt's show was prophetic in its insistence on confusing the boundaries between art and what we might dub "creative applied science." According to the catalog, "no visitor to the exhibition, unless he reads all the notes relating to all the works, will know whether he is looking at something made by an artist, engineer, mathematician, or architect." So the comically dysfunctional robot by Nam June Paik, *Robot K-456* (1964), featured on the catalog's cover and described as "a female robot known for her disturbing and idiosyncratic behavior," would face off against a balletic *Colloquy of Mobiles* (1968) from second-order cybernetician Gordon Pask. Pask worked with a London theater

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[48] *The Human Use of Human Beings* (1954 edition), p. 46.

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designer to craft a spindly "male" apparatus of hinges and rods, set up to communicate with bulbous "female" fiberglass entities nearby. Whether anyone could actually map the quiddities of the program (or glean its reactionary gender theater) without reading the catalog essay is an open question. What is significant is Pask's focus on the behaviors of his automata, their interactivity, their responsiveness within an artificially modulated environment, and their "reflection" of human behaviors.

The ICA's "Cybernetic Serendipity" introduced an important paradigm: the machinic ecosystem, in which the viewer was a biological part, tasked with figuring out just what the triggers for interaction might be. The visitors in those London galleries suddenly became "cybernetic organisms"—cyborgs—since to experience the art adequately, one needed to enter a kind of symbiotic colloquy with the servomechanisms. This turn toward human-machine interactive environments as an aesthetic becomes clearer when we examine a few other artworks from the period, beginning with one constituting an early instance of emergent behavior—*Senster,* the interactive sculpture by artist/engineer Edward Ihnatowicz (1970), celebrated by medical robotics engineer Alex Zivanovic, editor of a Web site devoted to Ihnatowicz's little-known career, as "one of the first computer controlled interactive robotic works of art." Here, "the computer" makes its entry (albeit a twelve-bit, limited device). But rather than "intelligence," Ihnatowicz sought to make an avatar of affective behavior. Key to *Senster's* uncanny success was the programming with which Ihnatowicz constrained the fifteen-foot-long hydraulic apparatus (its hinge design and looming appearance inspired by a lobster claw) to convey shyness in responding to humans in its proximity. *Senster's* sound channels and motion sensors were set to recoil at loud noises and sudden aggressive movements. Only those humans willing to speak softly and modulate their gestures would be rewarded by *Senster's* quiet, inquisitive approach—an experience that became real for Ihnatowicz himself when he first assembled the program and the machine turned to him solicitously after he'd cleared his throat.

In these artistic uses of cybernetic beings, we sense a growing necessity to train the public to experience itself as embedded in a technologized environment, modifying itself to communicate intuitively with machines. This necessity had already become explicit in Tsai's "Cybernetic Sculpture" show. Those experiencing his immersive installation were expected to experiment with machinic life: What behaviors would trigger the servomechanisms? Likely, the human gallery attendant would have had to explain the protocol: "Clap your hands—that gets the sculptures to respond." As an early critic described it:

> A grove of slender stainless-steel rods rises from a plate. This base vibrates at 30 cycles per second; the rods flex rapidly, in harmonic curves. Set in a dark room, they are lit by strobes. The pulse of the flashing lights varies—they are connected to sound and proximity sensors. The result is that when one approaches a Tsai or makes a noise in its vicinity, the thing responds. The rods appear to move; there is a shimmering, a flashing, an eerie ballet of metal, whose apparent movements range from stillness to jittering and back to a slow, indescribably sensuous undulation.[49]

[49] Robert Hughes, *Time* magazine (October 2, 1972) review of Tsai exhibition at Denise René gallery.

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Like *Senster,* the apparatus stimulated (and simulated) an affective rather than rational interaction. Humans felt they were encountering behaviors indicative of responsive life; Tsai's entities were often classed as "vegetal" or "aquatic." Such environmental and kinetic ambitions were widespread in the international art world of the time. Beyond the stable at Howard Wise, there were the émigrés forming the collective GRAV in Paris, the "cybernetic architectures" of Nicolas Schöffer, the light and plastic gyrations of the German Zero Gruppe, and so on—all defining and informing the genre of installation art to come.

The artistic use of cybernetic beings in the late sixties made no investment in "intelligence." Knowing machines were dumb and incapable of emotion, these creators were confident in staging frank simulations. What interested them were machinic motions evoking drives, instincts, and affects; they mimicked sexual and animal behaviors, as if below the threshold of consciousness. Such artists were uninterested in the manipulation of data or information (although Hans Haacke would move in that direction by 1972 with his "Real-Time Systems" works). The cybernetic culture that artists and scientists were putting in place on two continents embedded the human in the technosphere and seduced perception with the graceful and responsive behaviors of the machinic phylum. "Artificial" and "natural" intertwined in this early cybernetic aesthetic.

But it wouldn't end here. Crucial to the expansion of this uncritical, largely masculine set of cybernetic environments would be a radical, critical cohort of astonishing women artists emerging in the 1990s, fully aware of their predecessors in art and technology but perhaps more inspired by the feminist founders of the 1970 journal *Radical Software* and the cultural blast of Donna Haraway's inspiring 1984 polemic, "A Cyborg Manifesto." The creaky gender theater of Paik and Pask, the innocent creatures of Ihnatowicz and Tsai, were mobilized as savvy, performative, and postmodern, as in Lynn Hershman Leeson's *Dollie Clone Series* (1995-98) consisting of the interactive assemblages *CyberRoberta* and *Tillie, the Telerobotic Doll,* who worked the technosphere with the professionalism of burlesque, winking and folding us viewers into an explicit consciousness of our voyeuristic position as both seeing subjects and objects-to-be-looked-at.

The "innocent" technosphere established by male cybernetic sculptors of the 1960s was, by the 1990s, identified by feminist artists as an entirely suffusive condition demanding our critical attention. At the same time, feminists tackled the question of whose "intelligence" AI was attempting to simulate. For an artist such as Hershman Leeson, responding to the technical "triumph" of cloning Dolly the sheep, it was crucial to draw the connection between meat production and "meat machines." Hershman Leeson produced "dolls" as clones, offering a critical framing of the way contemporary individuation had become part of an ideological, replicative, plastic realm.

While the technofeminists of the 1990s and into the 2000s weren't all cyber all the time, their works nonetheless complicated the dominant machinic and kinetic qualities of male artists' previous techno-environments. The androgynous tele-cyborg in Judith Barry's *Imagination, Dead Imagine* (1991), for example, had no moving parts: He/she was comprised of pure signals, flickering projections on flat surfaces. In her setup, Barry commented on the alienating effects of late-20th-century technology. The image of an androgynous head fills an enormous cube made of ten-foot-square screens on

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five sides, mounted on a ten-foot-wide mirrored base. A variety of viscous and unpleasant-looking fluids (yellow, reddish-orange, brown), dry materials (sawdust? flour?), and even insects drizzle or dust their way down the head, whose stoic sublimity is made gorgeously virtual on the work's enormous screens. *Dead Imagine,* through its large-scale and cubic "Platonic" form, remains both artificial and locked into the body—refusing a detached "intelligence" as being no intelligence at all.

Artists in the new millennium inherit this critical tradition and inhabit the current paradigms of AI, which has slid from partial simulations to claims of intelligence. In the 1955 proposal thought to be the first printed usage of the phrase "artificial intelligence," computer scientist John McCarthy and his colleagues Marvin Minsky, Nathaniel Rochester, and Claude Shannon conjectured that "every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it." This modest theoretical goal has inflated over the past sixty-four years and is now expressed by Google DeepMind as an ambition to "Solve intelligence." Crack the code! But unfortunately, what we hear cracking is not code but small-scale capitalism, the social contract, and the scaffolding of civility. Taking away the jobs of taxi and truck drivers, roboticizing direct marketing, hegemonizing entertainment, privatizing utilities, and depersonalizing health care—are these the "whips" that Wiener feared we would learn to love?

Artists can't solve any of this. But they can remind us of the creative potential of the paths not taken—the forks in the road that were emerging around 1970, before "information" became capital and "intelligence" equaled data harvesting. Richly evocative of what can be done with contemporary tools when revisiting earlier possibilities is French artist Philippe Parreno's "firefly piece," so nicknamed to avoid having to iterate its actual title: *With a Rhythmic Instinction to Be Able to Travel Beyond Existing Forces of Life* (2014). Described by the artist as "an automaton," the sculptural installation juxtaposes a flickering projection of black-and-white drawings of fireflies with a band of oscillating green-on-black binary figures. The drawings and binary figures are animated using algorithms from mathematician John Horton Conway's 1970 Game of Life, a "cellular automaton."

Conway set up parameters for any square ("cell") to be lit ("alive") or dark ("dead") in an infinite, two-dimensional grid. The rules are summarized as follows: A single cell will quickly die of loneliness. But a cell touching three or more other "live" cells will also die, "due to crowding." A cell survives and thrives if it has just two neighbors . . . and so on. As one cell dies, it may create the conditions for other cells to survive, yielding patterns that appear to move and grow, shifting across the grid like evanescent neural impulses or bioluminescent clusters of diatoms. In Stephen Hawking's 2012 film *The Meaning of Life*, the narrator describes Conway's mathematical model as simulating "how a complex thing like the mind might come about from a basic set of rules," revealing the overweening ambitions that characterize contemporary AI: "[T]hese complex properties emerge from simple laws that contain no concepts like movement or reproduction," yet they produce "species," and cells "can even reproduce, just as life does in the real world." [50]

Just as life does? Artists know the blandishments of simulation and representation, the difference between the genius of artifice and the realities of what "life

[50] Narration in Stephen Hawking's *The Meaning of Life* (Smithson Productions, Discovery Channel, 2012).

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does." Parreno's piece is an intuitive assembly of our experience of "life" through embodied, perspectival engagement. Our consciousness is electrically (cybernetically) enmeshed, yet we don't respond as if this human-generated set of elegant simulations had its own *intelligence*.

The artistic use of cybernetic beings also reminds us that consciousness itself is not just "in here." It is streaming in and out, harmonizing those sensory, scintillating signals. Mind happens well outside the limits of the cranium (and its simulacrum, the "motherboard"). In Mary Catherine Bateson's paraphrase of her father Gregory's second-order cybernetics, mind is material "not necessarily defined by a boundary such as an envelope of skin."[51] Parreno pairs the simulations of art with the simulations of mathematics to force the Wiener-like point that any such model is not, by itself, just like life. Models are just that—parts of signaling systems constituting "intelligence" only when their creaturely counterparts engage them in lively meaning making. Contemporary AI has talked itself into a corner by instrumentalizing and particularizing tasks and subroutines, confusing these drills with actual wisdom. The brief cultural history offered here reminds us that views of data as intelligence, digital nets as "neural," or isolated individuals as units of life, were alien even to Conway's brute simulation.

We can stigmatize the stubborn arrogance of current AI as "right cybernetics," the path that led to current automated weapons systems, Uber's ill-disguised hostility to human workers, and the capitalist dreams of Google. Now we must turn back to left cybernetics—theoretical biologists and anthropologists engaged with a trans-species understanding of intelligent systems. Gregory Bateson's observation that corporations merely simulate "aggregates of parts of persons," with profit-maximizing decisions cut off from "wider and wiser parts of the mind," has never been more timely.[52]

The cybernetic epistemology offered here suggests a new approach. The individual mind is immanent, not only in the body but also in pathways outside the body, and there is a larger Mind, of which the individual mind is only a subsystem. This larger Mind, Bateson holds, is comparable to God, and is perhaps what some people mean by "God," but it is still immanent in the total interconnected social system and planetary ecology. This is not the collective delusion of an exterior "God" who speaks from outside human consciousness (this long-seated monotheistic conceit, Bateson suggests, leads to views of nature and environment as also outside the "individual" human, rendering them as "gifts to exploit"). Rather, Bateson's "God" is a placeholder for our evanescent experience of interacting consciousness-in-the-world: larger Mind as a result of inputs and actions that then become inputs for other actions in concert with other entities—webs of symbiotic relationships that form patterns we need urgently to sense and harmonize with.[53]

From Tsai in the 1970s to Hershman Leeson in the 1990s to Parreno in 2014, artists have been critiquing right cybernetics and plying alternative, embodied, environmental experiences of "artificial" intelligence. Their artistic use of cybernetic beings offers the wisdom of symbionts experienced in the kinds of poeisis that can be achieved in this world: rhythms of signals and intuitive actions that produce the

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[51] Mary Catherine Bateson, 1999 foreword to Gregory Bateson, *Steps to an Ecology of Mind* (Chicago: University of Chicago Press, 1972): xi.
[52] *Steps to an Ecology of Mind,* p. 452.
[53] Ibid., pp. 467-8.

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movements of life partnered with an electro-mechanical and -magnetic technosphere.
Life, in its mysterious negentropic entanglements with matter and Mind.

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Over nearly four decades, **Stephen Wolfram** *has been a pioneer in the development and application of computational thinking and responsible for many innovations in science, technology and business.*

His 1982 paper "Cellular Automata as Simple Self-Organizing Systems," written at the age of twenty-three, was the first of numerous significant scientific contributions aimed at understanding the origins of complexity in nature.

It was around this time that Stephen briefly came into my life. I had established The Reality Club, an informal gathering of intellectuals who met in New York City to present their work before peers in other disciplines. (Note: In 1996, The Reality Club went online as Edge.org*). Our first speaker? Stephen Wolfram, a "wunderkind" who had arrived in Princeton at the Institute for Advanced Study. I distinctly recall his focused manner as he sat down on a couch in my living room and spoke uninterrupted for about an hour before the assembled group.*

Since that time, Stephen has become intent making the world's knowledge easily computable and accessible. His program Mathematica *is the definitive system for modern technical computing.* Wolfram|Alpha *computes expert-level answers using AI technology. He considers his* Wolfram Language *to be the first true computational communication language for humans and AIs.*

I caught up with him again four years ago, when we arranged to meet in Cambridge, Massachusetts, for a freewheeling conversation about AI. Stephen walked in, said hello, sat down, and, looking at the video camera set up to record the conversation for Edge*, began to talk and didn't stop for two and a half hours.*

The essay that follows is an edited version of that session, which was a Wolfram master class of sorts and is an appropriate way to end this volume—just as Stephen's Reality Club talk in the '80s was a great way to initiate the ongoing intellectual enterprise whose result is the rich community of thinkers presenting their work to one another and to the public in this book.

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ARTIFICIAL INTELLIGENCE AND THE FUTURE OF CIVILIZATION

Stephen Wolfram

Stephen Wolfram *is a scientist, inventor, and the founder and CEO of Wolfram Research. He is the creator of the symbolic computation program* Mathematica *and its programming language,* Wolfram Language*, as well as the knowledge engine* Wolfram|Alpha*. He is also the author of* A New Kind of Science*.*

The following is an edited transcript from a live interview with him conducted in December 2015.

I see technology as taking human goals and making them automatically executable by machines. Human goals of the past have entailed moving objects from here to there, using a forklift rather than our own hands. Now the work we can do automatically, with machines, is mental rather than physical. It's obvious that we can automate many of the tasks we humans have long been proud of doing ourselves. What's the future of the human condition in that situation?

People talk about the future of intelligent machines and whether they'll take over and decide what to do for themselves. But the inventing of goals is not something that has a path to automation. Someone or something has to define what a machine's purpose should be—what it's trying to execute. How are goals defined? For a given human, they tend to be defined by personal history, cultural environment, the history of our civilization. Goals are uniquely human. Where the machine is concerned, we can give it a goal when we build it.

What kinds of things have intelligence, or goals, or purpose? Right now, we know one great example, and that's us—our brains, our human intelligence. Human intelligence, I once assumed, is far beyond anything else that exists naturally in the world; it's the result of an elaborate process of evolution and thus stands apart from the rest of existence. But what I've realized, as a result of the science I've done, is that this is not the case.

People might say, for instance, "The weather has a mind of its own." That's an animist statement and seems to have no place in modern scientific thinking. But it's not as silly as it sounds. What does the human brain do? A brain receives certain input, it computes things, it causes certain actions to happen, it generates a certain output. Like the weather. All sorts of systems are, effectively, doing computations—whether it's a brain or, say, a cloud responding to its thermal environment.

We can argue that our brains are doing vastly more sophisticated computations than those in the atmosphere. But it turns out that there's a broad equivalence between the kinds of computations that different kinds of systems do. This renders the question of the human condition somewhat poignant, because it seems we're not as special as we thought. There are all those different systems of nature that are pretty much equivalent, in terms of their computational capabilities.

What makes us different from all those other systems is the particulars of our history, which give us our notions of purpose and goals. That's a long way of saying that when the box on our desk thinks as well as the human brain does, what it still won't have, intrinsically, are goals and purposes. Those are defined by our particulars—our particular biology, our particular psychology, our particular cultural history.

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When we consider the future of AI, we need to think about the goals. That's what humans contribute; that's what our civilization contributes. The execution of those goals is what we can increasingly automate. What will the future of humans be in such a world? What will there be for them to do? One of my projects has been to understand the evolution of human purposes over time. Today we've got all kinds of purposes. If you look back a thousand years, people's goals were quite different: How do I get my food? How do I keep myself safe? In the modern Western world, for the most part you don't spend a large fraction of your life thinking about those purposes. From the point of view of a thousand years ago, some of the goals people have today would seem utterly bizarre—for example, like exercising on a treadmill. A thousand years ago that would sound like a crazy thing to do.

What will people be doing in the future? A lot of purposes we have today are generated by scarcity of one kind or another. There are scarce resources in the world. People want to get more of something. Time itself is scarce in our lives. Eventually, those forms of scarcity will disappear. The most dramatic discontinuity will surely be when we achieve effective human immortality. Whether this will be achieved biologically or digitally isn't clear, but inevitably it will be achieved. Many of our current goals are driven in part by our mortality: "I'm only going to live a certain time, so I'd better get this or that done." And what happens when most of our goals are executed automatically? We won't have the kinds of motivations we have today. One question I'd like an answer for is, What do the derivatives of humans in the future end up choosing to do with themselves? One of the potential bad outcomes is that they just play video games all the time.

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The term "artificial intelligence" is evolving, in its use in technical language. These days, AI is very popular, and people have some idea of what it means. Back when computers were being developed, in the 1940s and 1950s, the typical title of a book or a magazine article about computers was "Giant Electronic Brains." The idea was that just as bulldozers and steam engines and so on automated mechanical work, computers would automate intellectual work. That promise turned out to be harder to fulfill than many people expected. There was, at first, a great deal of optimism; a lot of government money got spent on such efforts in the early 1960s. They basically just didn't work.

There are a lot of amusing science-fiction-ish portrayals of computers in the movies of that time. There's a cute one called *Desk Set,* which is about an IBM-type computer being installed in a broadcasting company and putting everybody out of a job. It's cute because the computer gets asked a bunch of reference-library questions. When my colleagues and I were building Wolfram|Alpha, one of the ideas we had was to get it to answer all of those reference-library questions from *Desk Set*. By 2009, it could answer them all.

In 1943, Warren McCulloch and Walter Pitts came up with a model for how brains conceptually, formally, might work—an artificial neural network. They saw that their brainlike model would do computations in the same way as Turing Machines. From their work, it emerged that we could make brainlike neural networks that would act as general computers. And in fact, the practical work done by the ENIAC folks and John

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von Neumann and others on computers came directly not from Turing Machines but through this bypath of neural networks.

But simple neural networks didn't do much. Frank Rosenblatt invented a learning device he called the perceptron, which was a one-layer neural network. In the late sixties, Marvin Minsky and Seymour Papert wrote a book titled *Perceptrons*, in which they basically proved that perceptrons couldn't do anything interesting, which is correct. Perceptrons could only make linear distinctions between things. So the idea was more or less dropped. People said, "These guys have written a proof that neural networks can't do anything interesting, therefore no neural networks can do anything interesting, so let's forget about neural networks." That attitude persisted for some time.

Meanwhile, there were a couple of other approaches to AI. One was based on understanding, at a formal level, symbolically, how the world works; and the other was based on doing statistics and probabilistic kinds of things. With regard to symbolic AI, one of the test cases was, Can we teach a computer to do something like integrals? Can we teach a computer to do calculus? There were tasks like machine translation, which people thought would be a good example of what computers could do. The bottom line is that by the early seventies, that approach had crashed.

Then there was a trend toward devices called expert systems, which arose in the late seventies and early eighties. The idea was to have a machine learn the rules that an expert uses and thereby figure out what to do. That petered out. After that, AI became little more than a crazy pursuit.

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I had been interested in how you make an AI-like machine since I was a kid. I was interested particularly in how you take the knowledge we humans have accumulated in our civilization and automate answering questions on the basis of that knowledge. I thought about how you could do that symbolically, by building a system that could break down questions into symbolic units and answer them. I worked on neural networks at that time and didn't make much progress, so I put it aside for a while.

Back in mid-2002 to 2003, I thought about that question again: What does it take to make a computational knowledge system? The work I'd done by then pretty much showed that my original belief about how to do this was completely wrong. My original belief had been that in order to make a serious computational knowledge system, you first had to build a brainlike device and then feed it knowledge—just as humans learn in standard education. Now I realized that there wasn't a bright line between what is intelligent and what is simply computational.

I had assumed that there was some magic mechanism that made us vastly more capable than anything that was just computational. But that assumption was wrong. This insight is what led to Wolfram|Alpha. What I discovered is that you can take a large collection of the world's knowledge and automatically answer questions on the basis of it, using what are essentially merely computational techniques. It was an alternative way to do engineering—a way that's much more analogous to what biology does in evolution.

In effect, what you normally do when you build a program is build it step-by-step. But you can also explore the computational universe and mine technology from that universe. Typically, the challenge is the same as in physical mining: That is, you find a supply of, let's say, iron, or cobalt, or gadolinium, with some special magnetic properties,

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and you turn that special capability to a human purpose, to something you want technology to do. In the case of magnetic materials, there are plenty of ways to do that. In terms of programs, it's the same story. There are all kinds of programs out there, even tiny programs that do complicated things. Could we entrain them for some useful human purpose?

And how do you get AIs to execute your goals? One answer is to just talk to them, in the natural language of human utterances. It works pretty well when you're talking to Siri. But when you want to say something longer and more complicated, it doesn't work well. You need a computer language that can represent sophisticated concepts in a way that can be progressively built up and isn't possible in natural language. What my company spent a lot of time doing was building a knowledge-based language that incorporates the knowledge of the world directly into the language. The traditional approach to creating a computer language is to make a language that represents operations that computers intrinsically know how to do: allocating memory, setting values of variables, iterating things, changing program counters, and so on. Fundamentally, you're telling computers to do things in your own terms. My approach was to make a language that panders not to the computers but to the humans, to take whatever a human thinks of and convert it into some form that the computer can understand. Could we encapsulate the knowledge we'd accumulated, both in science and in data collection, into a language we could use to communicate with computers? That's the big achievement of my last thirty years or so—being able to do that.

Back in the 1960s, people would say things like, "When we can do such-and-such, we'll know we have AI. When we can do an integral from a calculus course, we'll know we have AI. When we can have a conversation with a computer and make it seem human. . . ," et cetera. The difficulty was, "Well, gosh, the computer just doesn't know enough about the world." You'd ask the computer what day of the week it was, and it might be able to answer that. You'd ask it who the President was, and it probably couldn't tell you. At that point, you'd know you were talking to a computer and not a person. But now when it comes to these Turing Tests, people who've tried connecting, for example, Wolfram|Alpha to their Turing Test bots find that the bots lose every time. Because all you have to do is start asking the machine sophisticated questions and it will answer them! No human can do that. By the time you've asked it a few disparate questions, there will be no human who knows all those things, yet the system will know them. In that sense, we've already achieved good AI, at that level.

Then there are certain kinds of tasks easy for humans but traditionally very hard for machines. The standard one is visual object identification: What is this object? Humans can recognize it and give some simple description of it, but a computer was just hopeless at that. A couple of years ago, though, we brought out a little image-identification system, and many other companies have done something similar—ours happens to be somewhat better than the rest. You show it an image, and for about ten thousand kinds of things, it will tell you what it is. It's fun to show it an abstract painting and see what it says. But it does a pretty good job.

It works using the same neural-network technology that McCulloch and Pitts imagined in 1943 and lots of us worked on in the early eighties. Back in the 1980s, people successfully did OCR—optical character recognition. They took the twenty-six letters of the alphabet and said, "OK, is that an A? Is that a B? Is that a C?" and so on.

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That could be done for twenty-six different possibilities, but it couldn't be done for ten thousand. It was just a matter of scaling up the whole system that makes this possible today. There are maybe five thousand picturable common nouns in English, ten thousand if you include things like special kinds of plants and beetles which people would recognize with some frequency. What we did was train our system on 30 million images of these kinds of things. It's a big, complicated, messy neural network. The details of the network probably don't matter, but it takes about a quadrillion GPU operations to do the training.

Our system is impressive because it pretty much matches what humans can do. It has about the same training data humans have—about the same number of images a human infant would see in the first couple of years of its life. Roughly the same number of operations have to be done in the learning process, using about the same number of neurons in at least the first levels of our visual cortex. The details are different; the way these artificial neurons work has little to do with how the brain's neurons work. But the concept is similar, and there's a certain universality to what's going on. At the mathematical level, it's a composition of a very large number of functions, with certain continuity properties that let you use calculus methods to incrementally train the system. Given those attributes, you can end up with something that does the same job human brains do in physiological recognition.

But does this constitute AI? There are a few basic components. There's physiological recognition, there's voice-to-text, there's language translation—things humans manage to do with varying degrees of difficulty. These are essentially some of the links to how we make machines that are humanlike in what they do. For me, one of the interesting things has been incorporating those capabilities into a precise symbolic language to represent the everyday world. We now have a system that can say, "This is a glass of water." We can go from a picture of a glass of water to the *concept* of a glass of water. Now we have to invent some actual symbolic language to represent those concepts.

I began by trying to represent mathematical, technical kinds of knowledge and went on to other kinds of knowledge. We've done a pretty good job of representing objective knowledge in the world. Now the problem is to represent everyday human discourse in a precise symbolic way—a knowledge-based language intended for communication between humans and machines, so that humans can read it and machines can understand it, too. For instance, you might say "X is greater than 5." That's a predicate. You might also say, "I want a piece of chocolate." That's also a predicate. It has an "I want" in it. We have to find a precise symbolic representation of the desires we express in human natural language.

In the late 1600s, Gottfried Leibniz, John Wilkins, and others were concerned with what they called philosophical languages—that is, complete, universal, symbolic representations of things in the world. You can look at the philosophical language of John Wilkins and see how he divided up what was important in the world at the time. Some aspects of the human condition have been the same since the 1600s. Some are very different. His section on death and various forms of human suffering was huge; in today's ontology, it's a lot smaller. It's interesting to see how a philosophical language of today would differ from a philosophical language of the mid-1600s. It's a measure of our progress. Many such attempts at formalization have happened over the years. In

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mathematics, for example: Whitehead and Russell's *Principia Mathematica* in 1910 was the biggest showoff effort. There were previous attempts by Gottlob Frege and Giuseppe Peano that were a little more modest in their presentation. Ultimately, they were wrong in what they thought they should formalize: They thought they should formalize some process of mathematical proof, which turns out not to be what most people care about.

With regard to a modern analog of the Turing Test, it's an interesting question. There's still the conversational bot, which is Turing's idea. That one hasn't been solved yet. It will be solved—the only question is, What is the application for which it is solved? For a long time I would ask, "Why should we care?"—because I thought the principal application would be customer service, which wasn't particularly high on my list. But customer service, where you're trying to interface, is just where you need this conversational language.

One big difference between Turing's time and ours is the method of communicating with computers. In his time, you typed something into the machine and it typed back a response. In today's world, it responds with a screen—as for instance, when you want to buy a movie ticket. How is a transaction with a machine different from a transaction with a human? The main answer is that there's a visual display. It asks you something, and you press a button, and you can see the result immediately. For example, in Wolfram|Alpha, when it's used inside Siri, if there's a short answer, Siri will tell you the short answer. But what most people want is the visual display, showing the infographic of this or that. This is a nonhuman form of communication that turns out to be richer than the traditional spoken, or typed, human communication. In most human-to-human communication, we're stuck with pure language, whereas in computer-to-human communication we have this much higher bandwidth channel—of visual communication.

Many of the most powerful applications of the Turing Test fall away now that we have this additional communication channel. For example, here's one we're pursuing right now. It's a bot that communicates about writing programs: You say, "I want to write a program. I want it to do this." The bot will say, "I've written this piece of program. This is what it does. Is this what you want?" Blah-blah-blah. It's a back-and-forth bot. Devising such systems is an interesting problem, because they have to have a model of a human if they're trying to explain something to you. They have to know what the human is confused about.

What has long been difficult for me to understand is, What's the point of a conventional Turing Test? What's the motivation? As a toy, one could make a little chat bot that people could chat with. That will be the next thing. The current round of deep learning—particularly, recurrent neural networks—is making pretty good models of human speech and human writing. We can type in, say, "How are you feeling today?" and it knows most of the time what sort of response to give. But I want to figure out whether I can automate responding to my email. I know the answer is "No." A good Turing Test, for me, will be when a bot can answer most of my email. That's a tough test. It would have to learn those answers from the humans the email is connected to. I might be a little bit ahead of the game, because I've been collecting data on myself for about twenty-five years. I have every piece of email for twenty-five years, every keystroke for twenty. I should be able to train an avatar, an AI, that will do what I can do—perhaps better than I could.

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People worry about the scenario in which AIs take over. I think something much more amusing, in a sense, will happen first. The AI will know what you intend, and it will be good at figuring out how to get there. I tell my car's GPS I want to go to a particular destination. I don't know where the heck I am, I just follow my GPS. My children like to remind me that once when I had a very early GPS—the kind that told you, "Turn this way, turn that way"—we ended up on one of the piers going out into Boston Harbor.

More to the point is that there will be an AI that knows your history, and knows that when you're ordering dinner online you'll probably want such-and-such, or when you email this person, you should talk to them about such-and-such. More and more, the AIs will suggest to us what we should do, and I suspect most of the time people will just go along with that. It's good advice—better than what you would have figured out for yourself.

As far as the takeover scenario is concerned, you can do terrible things with technology and you can do good things with technology. Some people will try to do terrible things with technology, and some people will try to do good things with technology. One of the things I like about today's technology is the equalization it has produced. I used to be proud that I had a better computer than anybody I knew; now we all have the same kind of computers. We have the same smartphones, and pretty much the same technology can be used by a decent fraction of the planet's 7 billion people. It's not the case that the king's technology is different from everybody else's. That's an important advance.

The great frontier five hundred years ago was literacy. Today, it's doing programming of some kind. Today's programming will be obsolete in a not very long time. For example, people no longer learn assembly language, because computers are better at writing assembly language than humans are, and only a small set of people need to know the details of how language gets compiled into assembly language. A lot of what's being done by armies of programmers today is similarly mundane. There's no good reason for humans to be writing Java code or JavaScript code. We want to automate the programming process so that what's important goes from what the human wants done to getting the machine, as automatically as possible, to do it. This will increase that equalization, which is something I'm interested in. In the past, if you wanted to write a serious piece of code, or program for something important and real, it was a lot of work. You had to know quite a bit about software engineering, you had to invest months of time in it, you had to hire programmers who knew this or you had to learn it yourself. It was a big investment.

That's not true anymore. A one-line piece of code already does something interesting and useful. It allows a vast range of people who couldn't make computers do things for them, make computers do things for them. Something I'd like to see is a lot of kids around the world learn the new capabilities of knowledge-based programming and then produce code that's effectively as sophisticated as what anybody in the top ranks can produce. This is within reach. We're at the point where anybody can learn to do knowledge-based programming, and, more important, learn to think computationally. The actual mechanics of programming are easy now. What's difficult is imagining things in a computational way.

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How do you teach computational thinking? In terms of how to do programming, it's an interesting question. Take nanotechnology. How did we achieve nanotechnology? Answer: We took technology as we understand it on a large scale and we made it very small. How to make a CPU chip on the atomic scale? Fundamentally, we use the same architecture as the CPU chip we know and love. That isn't the only approach one can take. Looking at what simple programs can do suggests that you can take even simple impoverished components and with the right compiler you can make them do interesting things. We don't do molecular-scale computing yet, because the ambient technology is such that you'd have to spend a decade building it. But we've got the components that are enough to make a universal computer. You might not know how to program with those components, but by doing searches in the space of possible programs, you'd start to amass building blocks, and you could then create a compiler for them. The surprising thing is that impoverished stuff is capable of doing sophisticated things, and the compilation step is not as gruesome as you might expect.

Just searching the computational universe and trying to find programs—building blocks—that are interesting is a good approach. A more traditional engineering approach—trying by pure thought to figure out how to build a universal computer—is a harder row to hoe. That doesn't mean it can't be done, but my guess is that we'll be able to do some amazing things just by finding the components and searching the possible programs we can make with them. Then it's back to the question about connecting human purposes to what is available from the system.

One question I'm interested in is, What will the world look like when most people can write code? We had a transition, maybe five hundred years ago or so, when only scribes and a small set of the population could read and write natural language. Today, a small fraction of the population can write code. Most of the code they write is for computers only. You don't understand things by reading code. But there will come a time when, as a result of things I've tried to do, the code is at a high enough level that it's a minimal description of what you're trying to do. It will be a piece of code that's understandable to humans but also executable by the machines.

Coding is a form of expression, just as writing in a natural language is a form of expression. To me, some simple pieces of code are poetic—they express ideas in a very clean way. There's an aesthetic aspect, much as there is to expression in a natural language. One feature of code is that it's immediately executable; it's not like writing. When you write something, somebody has to read it, and the brain that's reading it has to absorb the thoughts that came from the person who did the writing. Look at how knowledge has been transmitted in the history of the world. At level zero, one form of knowledge transmission is essentially genetic—that is, there's an organism, and its progeny has the same features that it had. Then there's the kind of knowledge transmission that happens with things like physiological recognition. A newborn creature has some neural network with some random connections in it, and as the creature moves around in the world, it starts recognizing kinds of objects and it learns that knowledge.

Then there's the level that was the big achievement of our species, which is natural language. The ability to represent knowledge abstractly enough that we can communicate it brain to brain, so to speak. Arguably, natural language is our species' most important invention. It's what led, in many respects, to our civilization.

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There's yet another level, and probably one day it will have a more interesting name. With knowledge-based programming, we have a way of creating an actual representation of real things in the world, in a precise and symbolic way. Not only is it understandable by brains and communicable to other brains and to computers, it's also immediately executable.

Just as natural language gave us civilization, knowledge-based programming will give us—what? One bad answer is that it will give us the civilization of the AIs. That's what we don't want to happen, because the AIs will do a great job communicating with one another and we'll be left out of it, because there's no intermediate language, no interface with our brains. What will this fourth level of knowledge communication lead to? If you were Caveman Ogg and you were just realizing that language was starting, could you imagine the coming of civilization? What should we be imagining right now?

This relates to the question of what the world would look like if most people could code. Clearly, many trivial things would change: Contracts would be written in code, restaurant recipes might be written in code, and so on. Simple things like that would change. But much more profound things would also change. The rise of literacy gave us bureaucracy, for example, which had already existed but dramatically accelerated, giving us a greater depth of governmental systems, for better or worse. How does the coding world relate to the cultural world?

Take high school education. If we have computational thinking, how does that affect how we study history? How does that affect how we study languages, social studies, and so on? The answer is, it has a great effect. Imagine you're writing an essay. Today, the raw material for a typical high school student's essay is something that's already been written; students usually can't generate new knowledge easily. But in the computational world, that will no longer be true. If the students know something about writing code, they'll access all that digitized historical data and figure out something new. Then they'll write an essay about something they've discovered. The achievement of knowledge-based programming is that it's no longer sterile, because it's got the knowledge of the world knitted into the language you're using to write code.

~ ~ ~

There's computation all over the universe: in a turbulent fluid producing some complicated pattern of flow, in the celestial mechanics of planetary interactions, in brains. But does computation have a purpose? You can ask that about any system. Does the weather have a goal? Does climate have a goal?

Can someone looking at Earth from space tell that there's anything with a purpose there? Is there a civilization there? In the Great Salt Lake, in Utah, there's a straight line. It turns out to be a causeway dividing two areas of the lake with different colors of algae, so it's a very dramatic straight line. There's a road in Australia that's long and straight. There's a railroad in Siberia that's long, and lights go on when a train stops at the stations. So from space you can see straight lines and patterns.

But are these clear enough examples of obvious purpose on Earth as viewed from space? For that matter, how do we recognize extraterrestrials out there? How do we tell if a signal we're getting indicates purpose? Pulsars were discovered in 1967, when we picked up a periodic flutter every second or so. The first question was, Is this a beacon?

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Because what else would make a periodic signal? It turned out to be a rotating neutron star.

One criterion to apply to a potentially purposeful phenomenon is whether it's minimal in achieving a purpose. But does that mean that it was built for the purpose? The ball rolls down the hill because of gravitational pull. Or the ball rolls down the hill because it's satisfying the principle of least action. There are typically these two explanations for some action that seems purposeful: the mechanistic explanation and the teleological. Essentially all of our existing technology fails the test of being minimal in achieving its purpose. Most of what we build is steeped in technological history, and it's incredibly non-minimal for achieving its purpose. Look at a CPU chip; there's no way that that's the minimal way to achieve what a CPU chip achieves.

This question of how to identify purposefulness is a hard one. It's an important question, because radio noise from the galaxy is very similar to CDMA transmissions from cell phones. Those transmissions use pseudo-noise sequences, which happen to have certain repeatability properties. But they come across as noise, and they're set up as noise, so as not to interfere with other channels. The issue gets messier. If we were to observe a sequence of primes being generated from a pulsar, we'd ask what generated them. Would it mean that a whole civilization grew up and discovered primes and invented computers and radio transmitters and did this? Or is there just some physical process making primes? There's a little cellular automaton that makes primes. You can see how it works if you take it apart. It has a little thing bouncing inside it, and out comes a sequence of primes. It didn't need the whole history of civilization and biology and so on to get to that point.

I don't think there is abstract "purpose," per se. I don't think there's abstract meaning. Does the universe have a purpose? Then you're doing theology in some way. There is no meaningful sense in which there is an abstract notion of purpose. Purpose is something that comes from history.

One of the things that might be true about our world is that maybe we go through all this history and biology and civilization, and at the end of the day the answer is "42," or something. We went through all those 4 billion years of various kinds of evolution and then we got to "42."

Nothing like that will happen, because of computational irreducibility. There are computational processes that you can go through in which there is no way to shortcut that process. Much of science has been about shortcutting computation done by nature. For example, if we're doing celestial mechanics and want to predict where the planets will be a million years from now, we could follow the equations, step-by-step. But the big achievement in science is that we're able to shortcut that and reduce the computation. We can be smarter than the universe and predict the endpoint without going through all the steps. But even with a smart enough machine and smart enough mathematics, we can't get to the endpoint without going through the steps. Some details are irreducible. We have to irreducibly follow those steps. That's why history means something. If we could get to the endpoint without going through the steps, history would be, in some sense, pointless.

So it's not the case that we're intelligent and everything else in the world is not. There's no enormous abstract difference between us and the clouds or us and the cellular automata. We cannot say that this brainlike neural network is qualitatively

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different from this cellular-automaton system. The difference is a detailed difference. This brainlike neural network was produced by the long history of civilization, whereas the cellular automaton was created by my computer in the last microsecond.

The problem of abstract AI is similar to the problem of recognizing extraterrestrial intelligence: How do you determine whether or not it has a purpose? This is a question I don't consider answered. We'll say things like, "Well, AI will be intelligent when it can do blah-blah-blah." When it can find primes. When it can produce this and that and the other. But there are many other ways to get to those results. Again, there is no bright line between intelligence and mere computation.

It's another part of the Copernican story: We used to think Earth was the center of the universe. Now we think we're special because we have intelligence and nothing else does. I'm afraid the bad news is that that isn't a distinction.

Here's one of my scenarios. Let's say there comes a time when human consciousness is readily uploadable into digital form, virtualized and so on, and pretty soon we have a box of a trillion souls. There are a trillion souls in the box, all virtualized. In the box, there will be molecular computing going on—maybe derived from biology, maybe not. But the box will be doing all kinds of elaborate stuff. And there's a rock sitting next to the box. Inside a rock, there are always all kinds of elaborate stuff going on, all kinds of subatomic particles doing all kinds of things. What's the difference between the rock and the box of a trillion souls? The answer is that the details of what's happening in the box were derived from the long history of human civilization, including whatever people watched on YouTube the day before. Whereas the rock has its long geological history but not the particular history of our civilization.

Realizing that there isn't a genuine distinction between intelligence and mere computation leads you to imagine that future—the endpoint of our civilization as a box of trillion souls, each of them essentially playing a video game, forever. What is the "purpose" of that?

HOUSE_OVERSIGHT_016412

From: Morris, Paul V [redacted]
Sent: 1/15/2019 4:44:33 PM
To: jeffrey E. [jeevacation@gmail.com]
Subject: Opportunity Zones
Attachments: image001.jpg; image002.jpg; image003.jpg; image004.jpg

Importance: High

Hope all well, are you doing anything around these or clients?

In a former warehouse on a dimly lit street in the South Bronx, developers sipping Puerto Rican moonshine listened as a local official urged them to capture a new U.S. tax break by rebuilding the decaying neighborhood.

In Alabama, a young lawyer quit his job after seeing the same tax break's potential to help one of the nation's poorest states. He now spends his days driving his Hyundai from town to town, slideshow at the ready, hoping to connect investors with communities.

And on a conference call with potential clients, a prominent hedge fund executive pitched investments in a boutique hotel in Oakland, which he described as San Francisco's Brooklyn. The project is eligible for the same tax break, designed to help the poor.

Betting on Opportunity Zones

Sales of development sites are surging in areas eligible for tax breaks

Source: Real Capital Analytics

Fervor about opportunity zones is heating up across the U.S. For a limited time, investors who develop real estate or fund businesses in these areas are able to defer capital gains on profits earned elsewhere and completely eliminate them on new investments in 8,700 low-income census tracts. The goal is to reinvigorate these areas. But the question is whether the 2017 tax law will, as U.S. Treasury Secretary Steven Mnuchin predicts, pump $100 billion into places that need it most, or if investors will play it safe by funding projects in a few zones already on the upswing.

QuicktakeWill 'Opportunity Zones' Help the Rich, the Poor or Both?

There's no lack of optimism among officials in shrinking Rust Belt towns, wind-swept Western landscapes and hurricane-ravaged Puerto Rico, who hope to jump-start local economies. The incentives are so flexible they could be used for everything from affordable housing to solar farms.

Yet on the investor side, much of the attention is fixed on how to turn a profit in already thriving areas. They include neighborhoods surrounding Manhattan, Atlantic beach towns drawing vacation-home developers, bedroom communities near Silicon Valley and anomalies like Portland, Oregon, where the entire downtown was deemed eligible for the breaks.

"The phrase I keep thinking of is 'gold rush,' " said Michael Lortz, an accountant who works with developers in Portland. "There's a lot of money from out of town that's coming here."

Already, a policy debate is raging. Backers are urging people to reserve judgment and say the tax breaks have galvanized cities, businesses and investors to think creatively about boosting parts of the country most in need. Critics say the incentives were poorly calibrated and may amount to a boondoggle far in excess of the official $1.6 billion projected cost.

Americans may have to wait months or years to learn which side is right. That's because the law doesn't require investors to disclose projects, making it difficult to tell which areas are benefiting the most.

But there's plenty of evidence that a boom is brewing. Goldman Sachs Group Inc., which already had an investment team focusing on struggling communities, has disclosed about $150 million in projects in recent months. Purchases of sites inside opportunity zones spiked as the tax law took effect, outpacing growth in other areas, according to Real Capital Analytics, which tracks property sales. Altogether, investors spent 62 percent more on properties eligible for tax breaks in the 12 months through September, compared with those in the same census tracts a year earlier, its data show.

Here are snapshots of what's happening across America:

Bronx Boost

Port Morris Distillery, which makes a high-alcohol rum called pitorro, was the perfect spot for an opportunity zone pitch. It's on a block with a colorful mural, industrial buildings ready for loft conversions and views of the Manhattan skyline. Much of the surrounding South Bronx is now an opportunity zone.

"We have always been the most ignored," Marlene Cintron, the borough's head of economic development, told an audience of developers and lawyers in November. "These opportunity zones are here for you to take advantage of them."

The case for the Bronx, where incomes are among the lowest in New York, is that it's the last borough awaiting revitalization. The tax incentives are designed to unleash it. If developers can buy at current Bronx prices, before seeing a Brooklyn-like rise, the breaks would be massive.

The Bronx Tavern and Port Morris Distillery.
Photographer: David 'Dee' Delgado/Bloomberg

"Huge, huge upside that you're not going to get if you build a strip mall in Topeka," said Terri Adler, managing partner of law firm Duval & Stachenfeld LLP, who also spoke at the event.

Yet the Bronx faces a formidable problem: It's competing with other zones across the city, including waterfronts in Brooklyn and Queens with stronger momentum. The tax break Bronx officials hope will rejuvenate their borough may instead lure more money to what looks like a safer bet across the river.

In November, Amazon.com Inc. selected Long Island City for its next headquarters. Portions of that Queens neighborhood, including a former plastics factory the retailer plans to occupy, are inside opportunity zones, even though they're among the city's fastest-growing areas. In 2017, more apartments were built there than in any other neighborhood in the city.

Driving Alabama

Alex Flachsbart, 30, has a lot of time to talk when he's in his SUV crisscrossing Alabama. A lawyer who specialized in economic development grants and tax breaks, he quit his job last year to start Opportunity Alabama, aiming to connect capital to worthy projects. For the past several months, he's been educating people about opportunity zones, speaking to local officials, businesses and investors.

"I have done the OZ PowerPoint God knows how many times," Flachsbart, who grew up in the Bay Area, said from behind the wheel one day in December.

Alex Flachsbart gives a presentation on opportunity zones in Athens, Alabama. Photographer: Nicole Craine/Bloomberg

When he read about opportunity zones in a 2017 draft of the Tax Cuts and Jobs Act, his mind reeled. Here was an uncapped subsidy far more flexible than anything he'd used before. It could draw investment for an array of projects. He imagined funding startups in Huntsville, where NASA's presence has lured a deep bench of talented engineers, and the renovation of an old civic complex in Mobile.

Flachsbart's nonprofit—which has board members from the state's largest utility and its biggest bank, Regions Financial Corp.—is now in talks for 10 potential projects that need more than $100 million in equity investment, he said. None have been funded yet, but he's certain some will be. Meanwhile, he keeps driving.

Baltimore Billionaire

One of the arguments over opportunity zones is whether the U.S. is handing wealthy investors and companies big breaks on projects they would've done anyway. One example: Hedge fund executive and former White House spokesman Anthony Scaramucci plans to build a "swank, boutique hotel" in Oakland. The paperwork for the permit was filed months before the neighborhood was designated an opportunity zone.

But that project pales in comparison to what's happening in Baltimore. More than a year before President Donald Trump signed the law, real estate developer Steven Siegel helped negotiate one of the largest public financing deals of its kind for a client, a company owned by billionaire Kevin Plank, founder of athletic-wear maker Under Armour Inc.

Port Covington area of Baltimore.
Photographer: Sarah L. Voisin/The Washington Post via Getty Images

In 2016, Baltimore's city council approved a $660 million financing package for a 235-acre mixed-use development, including new offices for Under Armour, along the city's waterfront. The area was already designated as an enterprise zone and a brownfield site, connoting additional lucrative tax breaks, and the project attracted a $233 million investment from Goldman Sachs's urban investment group.

Then came the opportunity zone designation.

The tax break is only supposed to apply to real estate purchased after the law took effect. But lawyers across the country quickly began working around that to get the benefits for projects planned before the law was passed. Many tax experts have recommended sales to new entities. So long as the seller owns no more than 20 percent of the buyer, the transaction counts as arm's-length and qualifies.

Siegel said his firm, Weller Development, has found enough new investors to comply with the arm's-length requirement. The company has seen so much demand, he said, that he's looking to replicate the project elsewhere.

"We've been fielding a lot of inbound interest," Siegel said, declining to name cities that have approached him. "That stimulated us to take this show on the road."

Boulder Balks

In mid-December, during a marathon city council meeting that stretched past midnight, Boulder became perhaps the first jurisdiction in the country to reject its own opportunity

zone. Officials in the Colorado town imposed an 18-month moratorium on almost all development in its only census tract earmarked for the incentives.

The move highlights how local officials have the power to respond to criticisms of the law—in this case, that investors may rush to build projects the community doesn't want. Boulder has long been a favorite spot for growing companies because people want to live there, thanks to its college-town vibe and quick access to nature.

"People think we have too much" development, said Bob Yates, a council member. "We're not Detroit."

An eyebrow salon is surrounded by empty stores at Diagonal Plaza in Boulder. Photographer: Rachel Woolf/Bloomberg

Though Yates, a former telecom executive, opposed the moratorium and worries it will make things difficult for businesses in the zone, he understands why people in Boulder, a liberal enclave, were skeptical of an idea enacted by a Republican Congress. He just wishes his city would take a more measured approach.

The zone includes an aging mall called Diagonal Plaza. The tax incentives could have spurred investors to redevelop it to include affordable housing, which is sorely needed, he said.

"Boulder's teachers can't live in Boulder," he said. "It's not a healthy thing to have socioeconomic divide where lower-income people have to live outside of town to serve higher-income people in town."

Paul V. Morris
Managing Director – The Morris Group
Private Banking and Investment Group
Bank of America Merrill Lynch
One Bryant Park, 28th Floor
[redacted]

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SUPREME COURT OF THE STATE OF NEW YORK
APPELLATE DIVISION – FIRST DEPARTMENT

THE PEOPLE OF THE STATE OF NEW YORK, Respondent, - against - JEFFREY E. EPSTEIN, Defendant-Appellant.	App. Div. No. 6081 On Appeal from New York Supreme Court, New York County, Index No. 30129/10 (Pickholz, J.)

NOTICE OF MOTION BY NYP HOLDINGS, INC. TO UNSEAL APPELLATE BRIEFS

PLEASE TAKE NOTICE that, upon the accompanying affirmation of John M. Browning sworn to on January 11, 2019, together with the exhibits annexed thereto, the accompanying memorandum of law and all pleadings and proceedings heretofore had herein, non-party movant NYP Holdings, Inc., by its undersigned counsel, will move this Court at a term thereof to be held at the Appellate Division Courthouse located at 27 Madison Avenue, New York, New York 10010, on January 21, 2019, at 10:00 a.m., or as soon thereafter as counsel may be heard, for an order unsealing the briefs in the above-captioned appeal.

PLEASE TAKE FURTHER NOTICE that answering papers, if any, shall be served upon the undersigned on or before the last date permitted by CPLR 2214.

HOUSE_OVERSIGHT_016420

Dated: New York, New York
January 11, 2019

Respectfully submitted,

DAVIS WRIGHT TREMAINE LLP

By: _____
Robert D. Balin
John M. Browning

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Attorneys for Non-Party Movant NYP Holdings, Inc.

HOUSE_OVERSIGHT_016421

SUPREME COURT, APPELLATE DIVISION
FIRST DEPARTMENT

THE PEOPLE OF THE STATE OF NEW YORK, Respondent, - against - JEFFREY E. EPSTEIN, Defendant-Appellant.	App. Div. No. 6081 On Appeal from New York Supreme Court, New York County, Index No. 30129/10 (Pickholz, J.) **AFFIDAVIT OF SERVICE**

STATE OF NEW YORK)
) ss.:
COUNTY OF NEW YORK)

JOHN BROWNING, being duly sworn, states, I am not a party to the action, am over 18 years of age and reside in Kings County, New York. On January 14, 2018, I served a true and correct copy of the annexed by mail in the custody of Federal Express directed to the following:

Martin Weinberg
20 Park Place, Suite 1000
Boston, MA 02116

Karen Friedman Agnifilo
Assistant District Attorney – New York County
One Hogan Place
New York, New York 10013

David Aronberg
State Attorney
15th Judicial Circuit – Palm Beach County Florida
401 North Dixie Highway
West Palm Beach, FL 33401

Dexter Lee
Assistant U.S. Attorney
Southern District of Florida
99 N.E. 4th Street
Miami, FL 33132

Dated: New York, New York

HOUSE_OVERSIGHT_016422

January 11, 2019

Sworn to before me this
11th day of January, 2019

Notary Public

LORETTA E. PERRY
Notary Public, State of New York
No. 24-4931617
Qualified in Kings County
Commission Expires August 1, 2022

By: _____
John M. Browning

4848-4442-5859v.1 3930033-000039

HOUSE_OVERSIGHT_016423

SUPREME COURT OF THE STATE OF NEW YORK
APPELLATE DIVISION – FIRST DEPARTMENT

THE PEOPLE OF THE STATE OF NEW YORK,	:	App. Div. No. 6081
Respondent,	:	**AFFIRMATION OF JOHN M. BROWNING IN SUPPORT OF MOTION TO UNSEAL**
- against -	:	
JEFFREY E. EPSTEIN,	:	
Defendant-Appellant.	:	On Appeal from New York Supreme Court, New York County, Index No. 30129/10 (Pickholz, J.)

John M. Browning, an attorney duly admitted to practice before the Courts of the State of New York, affirms the following under penalties of perjury:

1. I am an associate of Davis Wright Tremaine LLP, attorneys for non-party movant NYP Holdings, Inc., publisher of the New York Post (the "Post") and I submit this affirmation in support of the Post's motion to unseal the briefs filed by the parties in the above-captioned appeal.

2. The grounds for unsealing the appeal briefs in this action are set forth in the accompanying memorandum of law. I submit this affirmation to annex relevant documents and to state facts that are relevant to this motion, of which I have personal knowledge.

3. Annexed hereto as Exhibit A is a true and correct copy of an article written by Julie K. Brown and published by the *Miami Herald* on November 28, 2018, entitled "Cops worked to put serial sex abuser in prison. Prosecutors worked to cut him a break."

4. Annexed hereto as Exhibit B is a true and correct copy of an article written by Rebecca Rosenberg and Danika Fears, which was published by the Post on January 7, 2015, entitled "DA's office 'went easy' on sex offender Epstein."

HOUSE_OVERSIGHT_016424

5. Annexed hereto as Exhibit C is a true and correct copy of an article written by Rebecca Rosenberg, Larry Celona, Susan Edelman and Isabel Vincent, which was published by the Post on December 1, 2018, entitled "Manhattan DA sided with pedophile billionaire after botching investigation."

6. On or about December 4, 2018, Post reporter Susan Edelman contacted Danny Frost, Director of Communications for Manhattan District Attorney Cyrus Vance Jr., and requested copies of the briefs filed by the District Attorney's office in the above-captioned appeal. Ms. Edelman stated that names of victims could be redacted before the briefs were disclosed.

7. Mr. Frost responded that he could not provide Ms. Edelman with copies of the briefs because they were filed under seal pursuant to N.Y. Civil Rights Law 50-b and that the District Attorney's office could only release the briefs, even with victims' names redacted, if this Court ordered the briefs to be unsealed.

8. Mr. Frost further indicated by email that "[i]f the Post petitions the court, and the court asks the People for our position, we will *not* oppose the petition for a redacted brief" (emphasis in original). A true and correct copy of that email correspondence is annexed hereto as Exhibit D.

9. On or about December 18, 2018, I contacted Jay Lefkowitz, who represented appellant Jeffrey Epstein in the above-captioned appeal. Mr. Lefkowitz told me that he no longer represents Mr. Epstein and referred me to Martin Weinberg, who currently acts as counsel for Mr. Epstein.

10. On or about December 20, 2018, I spoke with Mr. Weinberg and explained the nature of the Post's motion to unseal the redacted briefs and the position taken by the Manhattan

HOUSE_OVERSIGHT_016425

District Attorney. Mr. Weinberg told me that he was unable to take a position on the Post's motion without first reviewing it and reserved the right to file an opposition, if necessary.

11. On December 21, 2018, the Post filed a motion requesting an order unsealing the appellate briefs and directing the Manhattan District Attorney's Office to produce copies with the names of victims redacted (the "December 21 Motion").

12. On or about December 28, 2018, the Manhattan District Attorney's Office filed an affirmation in response to the Post's motion, signed by Assistant District Attorney Karen Friedman Agnifilo and dated December 28, 2018 (the "DA Affirmation"). A true and correct copy of the Affirmation is annexed hereto as Exhibit E.

13. On January 2, 2019, I spoke with Ms. Friedman Agnifilo to discuss the DA Affirmation. Ms. Friedman Agnifilo told me that there had been a miscommunication by Mr. Frost and that the District Attorney's Office did oppose the December 21 Motion. Ms. Friedman Agnifilo also told me that, in the view of the District Attorney's Office, the Post should give notice of their motion to unseal the appeal briefs to the prosecutors in Florida that handled the prosecution that led to Mr. Epstein's conviction for solicitation of prostitution from a minor. The Post disagrees with that position but nevertheless decided to moot any procedural issues related to requirements to notify the Florida prosecutors. Ms. Friedman Agnifilo subsequently informed me that the agency in Florida responsible for Mr. Epstein's prosecution was the Palm Beach County State Attorney's Office.

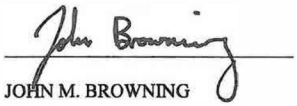
14. On January 3, 2019, I received an email from Mr. Weinberg stating that "after consideration of your request for the unsealing of the appellate briefs with redactions of certain identities, we take no position on behalf of Mr. Epstein." A true and correct copy of that email is annexed hereto as Exhibit F.

15. On January 4, 2019, the Post filed a letter with this Court voluntarily withdrawing the December 21 Motion without prejudice to refile in order to moot the procedural issues raised by the Manhattan District Attorney's Office with respect to furnishing notice to prosecutors in Florida. A true and correct copy of that letter is annexed as Exhibit G.

16. On or about January 10, 2019, I contacted the Palm Beach County State Attorney's Office to inform it of the Post's intention to file a motion to unseal the appellate briefs and to inquire about where to send a copy of the motion. A member of the Office of State Attorney David Aronberg instructed me to send a digital copy of the motion to e-postconviction@sa15.org and to send a paper copy to the State Attorney's main offices.

17. On or about January 10 and January 11, 2019, I spoke with Sarah J. Schall, Special Counsel to the U.S. Attorney in the Southern District of Florida, to inform her Office of the Post's intention to file a motion to unseal the appellate briefs and to inquire about where to send a copy of the motion. Ms. Schall instructed me to send a digital copy of the motion papers to her email address and to forward hard copies to Dexter Lee.

Dated: New York, New York
January 11, 2019



JOHN M. BROWNING

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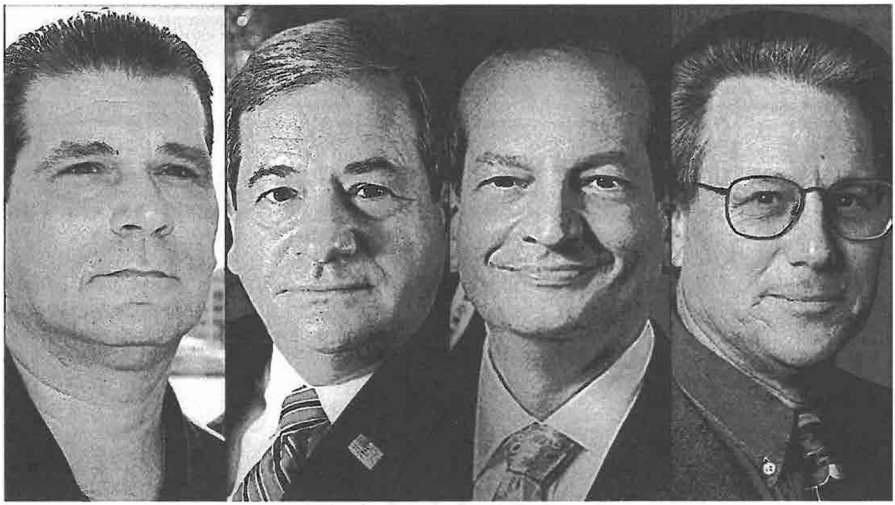
EXHIBIT A



Cops worked to put serial sex abuser in prison. Prosecutors worked to cut him a break

BY JULIE K. BROWN

NOV. 28, 2018

PERVERSION of JUSTICE

A decade before #MeToo, a multimillionaire sex offender from Florida got the ultimate break.

Palm Beach, Florida

November 2004

Jane Doe

Michelle Licata climbed a narrow, winding staircase, past walls covered with photographs of naked girls. At the top of the stairwell was a vast master bed and bath, with cream-colored shag carpeting and a hot pink and mint green sofa.

The room was dimly lit and very cold.

There was a vanity, a massage table and a timer.

A silver-haired man wearing nothing but a white towel came into the room. He lay facedown on a massage table, and while talking on a phone, directed Licata to rub his back, legs and feet.

Micelle Licata, is one of the over 100 middle school and high school-aged girls that Palm Beach billionaire, Jeffrey Epstein, is accused of sexually assaulting. Licata, now an adult living near Nashville, recalls her experience with

Epstein at his Palm Beach mansion while she was a sophomore at Royal Palm Beach High School.
EMILY MICHOT *EMICHOT@MIAMIHERALD.COM*

After he hung up, the man turned over and dropped his towel, exposing himself. He told Licata to get comfortable and then, in a firm voice, told her to take off her clothes.

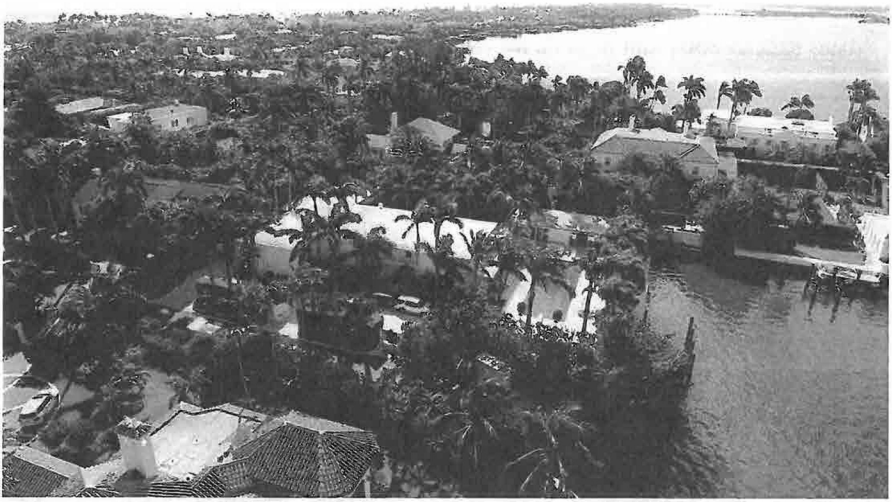
At 16, Licata had never before been fully naked in front of anyone. Shaking and panicked, she mechanically pulled off her jeans and stripped down to her underwear. He set the timer for 30 minutes and then reached over and unsnapped her bra. He then began touching her with one hand and masturbating himself with the other.

"I kept looking at the timer because I didn't want to have this mental image of what he was doing," she remembered of the massage. "He kept trying to put his fingers inside me and told me to pinch his nipples. He was mostly saying 'just do that, harder, harder and do this. ...' "

After he ejaculated, he stood up and walked to the shower, dismissing her as if she had been in history class.

It wasn't long before a lot of Licata's fellow students at Royal Palm Beach High School had heard about "a creepy old guy" named Jeffrey who lived in a pink waterfront mansion and was paying girls $200 to $300 to give him massages that quickly turned sexual.

Eventually, the Palm Beach police, and then the FBI, came knocking on Licata's door. In the police report, Licata was referred to as a Jane Doe in order to protect her identity as a minor.



Palm Beach home of registered sex offender, Jeffrey Epstein.
PEDRO PORTAL *PPORTAL@MIAMIHERALD.COM*

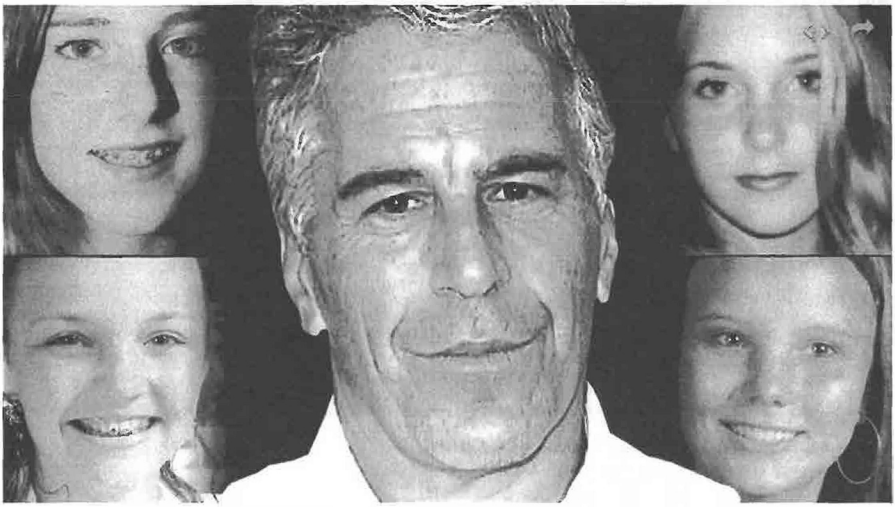
There would be many Jane Does to follow: Jane Doe No. 3, Jane Doe No. 4, Jane Does 5, 6, 7, 8 — and as the years went by — Jane Does 102 and 103.

Long before #MeToo became the catalyst for a women's movement about sexual assault — and a decade before the fall of Harvey Weinstein, Bill Cosby and U.S. Olympic gymnastics doctor Larry Nassar — there was Jeffrey Edward Epstein.

Epstein, a multimillionaire hedge fund manager whose friends included a constellation of entertainers, politicians, business titans and royalty, for years lured teenage girls to his Palm Beach mansion as part of a cult-like sex pyramid scheme, police in the town of Palm Beach found.

The girls arrived, sometimes by taxi, for trysts at all hours of the day and night. Few were told much more than that they would be paid to give an old man a massage — and that he might ask them to strip down to their underwear or get naked. But what began as a massage often led to masturbation, oral sex,

intercourse and other sex acts, police and court records show. The alleged abuse dates back to 2001 and went on for years.



Palm Beach multimillionaire Jeffrey Epstein is a free man, despite sexually abusing dozens of underage girls according to police and prosecutors. His victims have never had a voice, until now.
BY EMILY MICHOT | JULIE K. BROWN

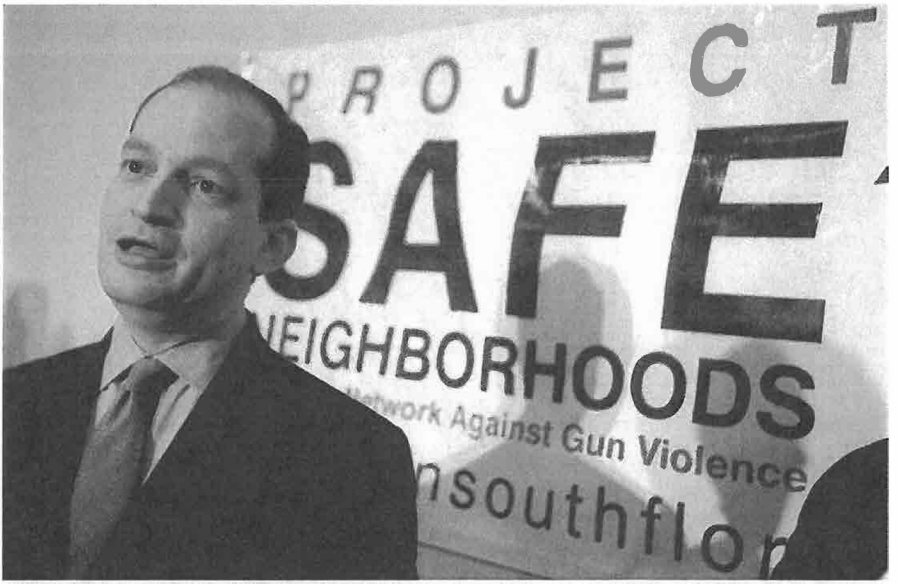
In 2007, despite ample physical evidence and multiple witnesses corroborating the girls' stories, federal prosecutors and Epstein's lawyers quietly put together a remarkable deal for Epstein, then 54. He agreed to plead guilty to two felony prostitution charges in state court, and in exchange, he and his accomplices received immunity from federal sex-trafficking charges that could have sent him to prison for life.

He served 13 months in a private wing of the Palm Beach County stockade. His alleged co-conspirators, who helped schedule his sex sessions, were never prosecuted.

The deal, called a federal non-prosecution agreement, was sealed so that no one — not even his victims — could know the full scope of Epstein's crimes and who

else was involved. The U.S. attorney in Miami, Alexander Acosta, was personally involved in the negotiations, records, letters and emails show.

Acosta is now a member of President Donald Trump's Cabinet. As U.S. secretary of labor, he has oversight over international child labor laws and human trafficking and had recently been mentioned as a possible successor to former U.S. Attorney General Jeff Sessions, who resigned under pressure in early November. It was reported on Thursday, a day after this story posted online, that he was no longer in the running.



Alex Acosta, Federal Attorney, speaks during a press conference celebrated during the opening sesion of South Florida Anti-Gang Summit at Miami Hilton Hotel on Sept. 29, 2008 in Miami, Fl. (Cristobal Herrera/Sun Sentinel/TNS)
CRISTOBAL HERRERA *TNS*

The Miami Herald analyzed thousands of pages of court records and lawsuits, witness depositions and newly released FBI documents, and also identified more than 80 women who say they were victimized. They are scattered around the

country and abroad. Until now, those victims — today in their late 20s and early 30s — have never spoken publicly about how they felt shamed, silenced and betrayed by the very people in the criminal justice system who were supposed to hold Epstein accountable.

"How come people who don't have money get sent to jail — and can't even make bail — and they have to do their time and sit there and think about what they did wrong? He had no repercussions and doesn't even believe he did anything wrong," said Licata, now 30.

Micelle Licata, is one of the over 100 middle school and high school-aged girls that Palm Beach billionaire, Jeffrey Epstein, is accused of sexually assaulting. Licata, now an adult living near Nashville, recalls her experience with Epstein at his Palm Beach mansion while she was a sophomore at Royal Palm Beach High School.
EMILY MICHOT *EMICHOT@MIAMIHERALD.COM*

Licata is among 36 women who were officially identified by the FBI and the U.S. Attorney's Office as victims of Epstein, now 65. But after the FBI case was closed

in 2008, witnesses and alleged victims testified in civil court that there were hundreds of girls who were brought to Epstein's homes, including girls from Europe, Latin America and former Soviet Republic countries.

But Acosta and Epstein's armada of attorneys — Harvard professor Alan Dershowitz, Jay Lefkowitz, Gerald Lefcourt, Jack Goldberger, Roy Black, Guy Lewis and former Whitewater special prosecutor Kenneth Starr — reached a consensus: Epstein would never serve time in a federal or state prison.

READ NEXT

LOCAL

Sex abuser Jeffrey Epstein was surrounded by powerful people. Here's a sampling

NOVEMBER 28, 2018 8:00 AM

POLICE UNDER PRESSURE

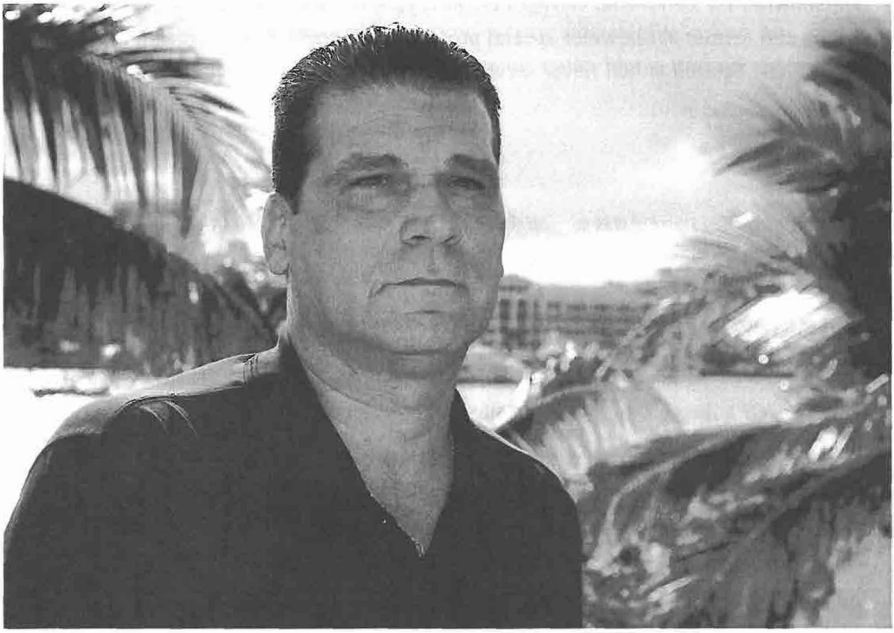
There were really just two people willing to risk their careers to go after Epstein: Palm Beach Police Chief Michael Reiter and Detective Joseph Recarey.

For Reiter, business tycoon Jeffrey Epstein wasn't any more formidable than any of the other 8,000 or so wealthy and powerful people living on the island. Police had handled sensational cases involving wealthy residents before — from the murders of heiresses to the rape case involving William Kennedy Smith, of the Kennedy family.

The easternmost town in Florida, Palm Beach is a 10.4-square-mile barrier island between the Intracoastal Waterway and the Atlantic Ocean populated by some of the richest people in the country. President Trump has his "winter White House" in Palm Beach, and the town makes news as much for its glitz as it does for its unusual efforts to preserve its well-mannered image, like banning shirtless joggers.

But it was a little surprising, even to Reiter, to learn that one of its residents had a revolving door of middle and high school girls coming to his gated compound throughout the day and night.

In their first on-the-record media interviews about the case, Reiter and Recarey revealed new details about the investigation, and how they were, in their view, pressured by then-Palm Beach State Attorney Barry Krischer to downgrade the case to a misdemeanor or drop it altogether.



Former Palm Beach County Police Detective Joe Recarey was the lead detective on the solicitation-of-minors case against billionaire Jeffrey Epstein.
EMILY MICHOT *EMICHOT@MIAMIHERALD.COM*

Between March of 2005 — when the case was opened — and seven months later, when police executed a search warrant at Epstein's home, Recarey had identified 21 possible victims, according to a copy of the unredacted police report obtained by the Herald. By the time police felt they had enough evidence to arrest Epstein on sex charges, they had identified about 35 possible underage victims and were tracking down at least a dozen more, the police report said.

"I was surprised at how quickly it snowballed. I thought at some point there would be a last interview, but the next victim would supply me with three or four more names and the next one had three or four names and it just kept getting bigger and bigger," Recarey said.

By then, word had gotten back to Epstein from some of the girls that they had been questioned by police. Epstein hired famed lawyer Alan Dershowitz.

"Alan Dershowitz flew down and met privately with Krischer," Recarey said. "And the shenanigans that happened, I don't think I've ever seen or heard of before."

Police reports show that Epstein's private investigators attempted to conduct interviews while posing as cops; that they picked through Reiter's trash in search of dirt to discredit him; and that the private investigators were accused of following the girls and their families. In one case, the father of one girl claimed he had been run off the road by a private investigator, police and court reports show.

Support investigative journalism

The Miami Herald obtained thousands of FBI and court records, lawsuits, and witness depositions, and went to federal court in New York to access sealed documents in the reporting of "Perversion of Justice." The Herald also tracked down more than 60 women who said they were victims, some of whom had never spoken of the abuse before.

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Several of the girls said they felt intimidated and frightened by Epstein and Sarah Kellen, the millionaire's assistant and alleged scheduler of massages, who warned them not to talk to police, according to the police report.

Dershowitz, in an interview with the Herald, said he had nothing to do with gathering background on the girls — or in directing anyone to follow the police, or the girls and their families.

"I'm not an investigator. My only job was to negotiate and try the case when it comes to trial," he said.

He nevertheless convinced Krischer that the girls would not be credible on the witness stand, according to Reiter and Recarey.

The defense team's investigators compiled dossiers on the victims in an effort to show that Epstein's accusers had troubled pasts.

Dershowitz met with Krischer and Recarey, sharing with them the results of an investigation into one of the girls, described by Dershowitz as "an accomplished drama student" who hurled profanities at his investigator at "a furious pace."

10/27/99 - OPINION - Barry Krischer; P.B.Co. State Attorney. (AM)

"Our investigation had discovered at least one of her websites and I am enclosing some examples ... the site goes on to detail, including photos, her apparent fascination with marijuana, " Dershowitz wrote in an undated letter to Recarey. He also disputed the claim that one of the defense team's private investigators had misrepresented himself as a police officer.

Recarey stood his ground.

"His attorneys showed us a MySpace page where one of the girls was holding a beer in her hand, and they said, 'oh look, she is underage drinking,' " Recarey recalled. "Well, tell me what teenager doesn't? Does that mean she isn't a victim because she drank a beer? Basically, what you're telling me is the only victim of a sexual battery could be a nun."

Krischer and the lead state prosecutor on the case, Assistant State Attorney Lanna Belohlavek, began to dodge Recarey and Reiter's phone calls and emails, and they dragged their feet on approving subpoenas, Reiter and Recarey said.

"Early on, it became clear that things had changed, from Krischer saying, 'we'll put this guy away for life,' to 'these are all the reasons why we aren't going to prosecute this,' " Reiter said.

Krischer, who is now retired and in private practice, did not respond to multiple requests from the Herald for comment. Belohlavek also did not respond to an email sent to her office.

"It became apparent to me that some of our evidence was being leaked to Epstein's lawyers, who began to question everything that we had in our probable cause affidavit," Reiter said.

The day of the search on Oct. 20, 2005, they found that most of Epstein's computer hard drives, surveillance cameras and videos had been removed from the house, leaving loose, dangling wires, according to the police report.

But the girls' description of the house squared with what detectives found, right down to the hot pink couch and the dresser drawer of sex toys in Epstein's bathroom.

Reiter said his own trash was disappearing from his house, as his life was put under Epstein's microscope. Private investigators hired by Epstein's lawyers even tracked down Reiter's grade school teachers, the former chief said. Questions were raised about donations that Epstein had made to the police department, even though Reiter had returned one of the donations shortly after the investigation began.

Recarey, meanwhile, said he began to take different routes to and from work, and even switched vehicles because he knew he was being tailed.

"At some point it became like a cat-and-mouse game. I would stop at a red light and go. I knew they were there, and they knew I knew they were there. I was concerned about my kids because I didn't know if it was someone that they hired just out of prison that would hurt me or my family," Recarey said.

Despite relentless political pressure, Reiter and Recarey soldiered on, and their determination yielded evidence that supported most of the girls' allegations, the former cops said. They had phone records that showed Epstein and his assistant,

Kellen, had called many of the girls. Epstein's flight logs showed that the calls were made when Epstein was in Palm Beach.

They obtained dozens of message pads from his home that read like a who's who of famous people, including magician David Copperfield and Donald Trump, an indication of Epstein's vast circle of influential friends. There were also messages from girls, and their phone numbers matched those of many of the girls Recarey had interviewed, Recarey said. They read: "Courtney called, she can come at 4," or "Tanya can't come at 7 p.m. tomorrow because she has soccer practice."

They also found naked photographs of underage girls in Epstein's closet, Recarey said.

There were also witnesses: Two of Epstein's butlers gave Recarey sworn interviews, confirming that young girls had been coming and going at the house. One of the butlers, Alfredo Rodriguez, told Recarey that when he was tasked with cleaning up the master bath after Epstein's sessions with the girls, he often discovered sex toys. Once, he accidentally stumbled on a high school girl, whom he identified, sleeping naked in Epstein's spa, he testified in a 2009 court deposition.

Rodriguez said he was given the job of paying the girls, telling Recarey that he was "a human ATM machine" because he was ordered by Epstein to keep $2,000 on him at all times. He was also assigned to buy the girls gifts. Rodriguez gave Recarey copies of pages from a book that Epstein and his staff kept with the names and phone numbers for many of the Palm Beach County girls, Recarey said.

Rodriguez, however, held onto the bulk of Epstein's "little black book," and in November 2009 tried to sell it for $50,000 to an undercover FBI agent posing as a victim's lawyer. He was arrested and sentenced in 2012 to federal prison, and died three years later following an illness. The book — listing personal phone numbers for a cavalcade of Epstein's powerful friends and celebrities — eventually became public as part of a civil lawsuit. It listed more than 100 female names and phone numbers under the headings "massage" in every city where Epstein had homes.

In May 2006, Recarey drew up probable cause affidavits, charging Epstein, two of his assistants and one recruiter with sex-related crimes. Instead, Krischer took what Recarey said was the unusual step of referring the case to a state grand jury. Epstein was indicted in state court on a minor charge of solicitation of prostitution.

Recarey said Krischer told him he didn't believe Epstein's accusers, and only two of them were called before the state grand jury investigating the case — even though police had lined up more than a dozen girls and witnesses at that time.

Believing that the case had been tainted, Reiter — that same month, May 2006 — took a very public stance against Krischer, writing a letter, which was released to the news media, calling on Krischer to remove himself from the case. The chief then referred it to the FBI, which opened its own investigation in July 2006, FBI records show.

Reiter said he was effectively blackballed in some Palm Beach circles as a result of going over Krischer's head, and their relationship, once strong, would never be the same.

Reiter has no regrets about what he did.

"There are challenges here that don't exist in a lot of other places because of the affluence in the community, but the only way I could approach this case was that none of that matters. The truth is still the truth. The facts are the facts. Everybody is treated the same."

In the years that followed, several of the victims obtained lawyers and filed civil lawsuits against Epstein. About two dozen lawsuits were filed, starting in 2008. The early cases were particularly brutal for his victims, the court records show. The girls faced fierce grilling from another pack of Epstein's civil attorneys, who questioned them about their boyfriends, drinking, drug use, social media posts, their parents and even their medical histories.

One girl was asked about her abortions, and her parents, who were Catholic and knew nothing about the abortions, were also deposed and questioned.

Licata said the questions from Epstein's civil lawyers were so intimate that she became paranoid that people were following her.

"His lawyers were just in my life inside and out. They asked if I had a baby, if I had an abortion, 'did you sleep with 30 different guys' and 'do you think that played a part?' I said, 'you're going to come at me like that when you represent a guy who is doing this to hundreds of girls? How do you sleep at night?' "

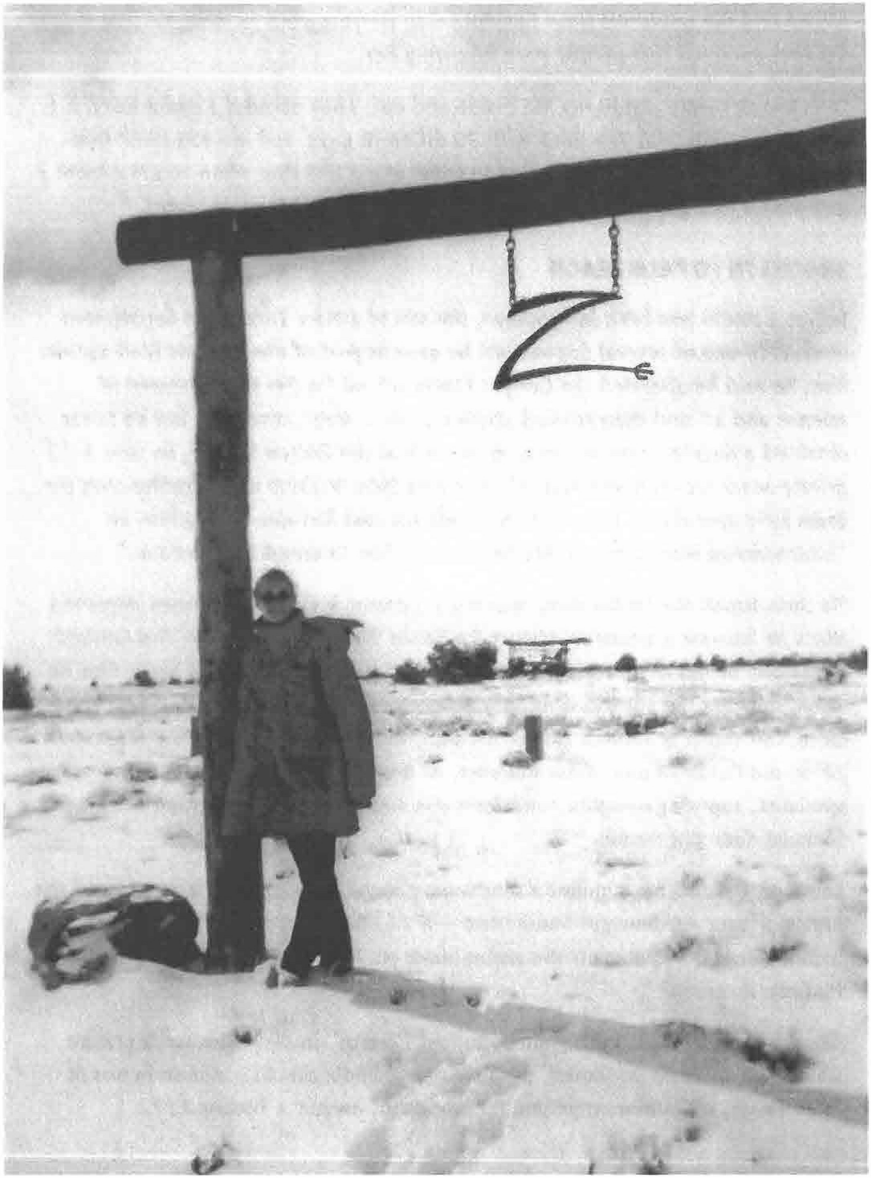
BROOKLYN TO PALM BEACH

Jeffrey Epstein was born in Brooklyn, the son of a New York parks department worker. In one of several depositions he gave as part of the lawsuits filed against him, he said he attended the Cooper Union school for the advancement of science and art and then studied physics at New York University. But he never obtained a degree, instead going on to teach at the Dalton School, an elite K-12 private academy on Manhattan's Upper East Side. Various news profiles over the years have speculated about how he made his vast fortune, calling him an "International Moneyman of Mystery" and "The Talented Mr. Epstein."

He then struck out on his own, opening J. Epstein & Co. His fortunes improved when he became a financial advisor for Leslie Wexner, founder of The Limited stores and owner of Victoria's Secret brands. Later, Epstein would boast that he would manage the portfolios of only those clients who had $1 billion or more.This much is known: He got his start on Wall Street after being offered a job by the father of one of his students. At Bear Stearns, he became a derivative specialist, applying complex math formulas and computer algorithms to evaluate financial data and trends.

Through Wexner, he acquired a seven-story stone mansion that is considered the largest private residence in Manhattan — a 21,000-square-foot fortress with heated sidewalks that spans the entire block on 71st Street between Fifth and Madison Avenues.

He also owns a 10,000-acre ranch, named "Zorro," in New Mexico, a private island called "Little St. James" in the Virgin Islands, the $13 million house in Palm Beach, a Gulfstream jet and, at one point, owned a Boeing 727.



Virginia Roberts says she was used as a sex slave for Jeffrey Epstein for years starting at the age of 16. Roberts says that Epstein also lent her out to some of his wealthy, powerful acquaintances for sex.
COURTESY OF VIRGINIA ROBERTS

He has never been in the Forbes 400 list of the wealthiest Americans, largely because the magazine has never been able to determine the source or the size of his wealth.

He has been dogged by questions about his financial dealings. A former business partner, Steven Hoffenberg, sued him in 2016, claiming that Epstein was the mastermind behind a $500 million Ponzi scheme that Hoffenberg was imprisoned for in 1995. Hoffenberg served 18 years for the scam, but he later dropped the lawsuit against Epstein.

In August, two of Hoffenberg's former investors rekindled the lawsuit against Epstein, but the case was dropped in October.

Epstein and his associate, British-born socialite Ghislaine Maxwell, were also accused in a 2015 federal civil suit of organizing underage sex parties on his private plane, nicknamed "The Lolita Express," and at Epstein's various homes. Maxwell, who has never been charged with wrongdoing, has denied allegations made in the lawsuit that she was Epstein's "madam." The suit, filed by victim Virginia Roberts, was settled in 2017.

Virginia Roberts was working at Mar-a-Lago when she was recruited to be a masseuse to Palm Beach hedge fund manager Jeffrey Epstein. She was lured into a life of depravity and sexual abuse.
BY EMILY MICHOT | JULIE K. BROWN

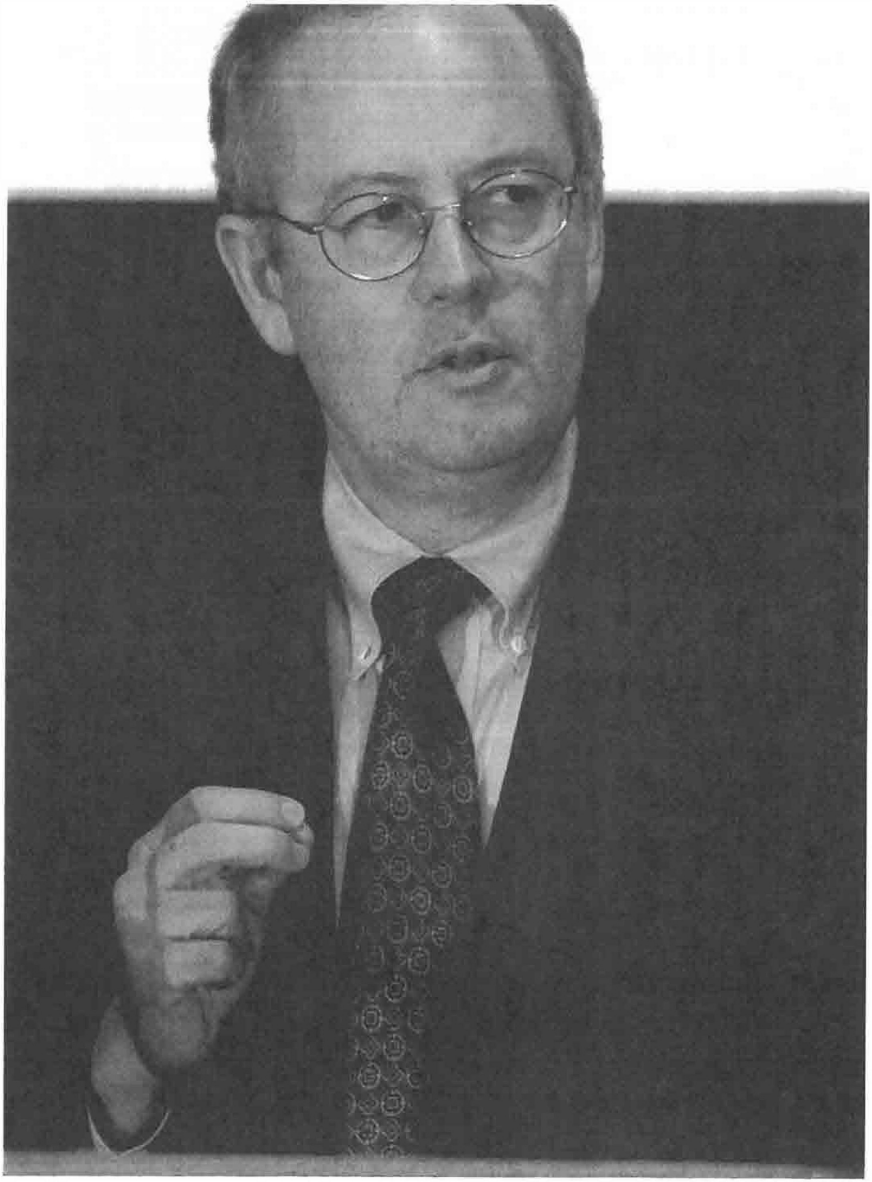
It was Epstein's contacts with powerful and famous people that first propelled him into the public spotlight. In 2002, he flew former President Bill Clinton, actor Kevin Spacey, comedian Chris Tucker and others to South Africa on his private jet as part of a fact-finding AIDS mission in support of the Clinton Foundation.

But Epstein, a Clinton donor who contributed hundreds of thousands of dollars to Democratic candidates and causes, realized that his Democratic connections weren't going to help him in 2006, when the federal prosecutor was Acosta, a conservative Republican appointed during the George W. Bush administration.

ENTER KENNETH STARR

Epstein's tactic: hire the most aggressive and politically connected lawyers that his money could buy.

At the top of his list: Kenneth Starr, a Republican icon because of his pursuit of Bill Clinton during the Whitewater investigation, which led to the impeachment (but not conviction) of the president after it was revealed he'd had sex with a young White House intern. Like Acosta, Starr had worked at the prestigious law firm Kirkland & Ellis. Epstein also tapped Jay Lefkowitz, also of Kirkland, who worked as a domestic policy advisor and later as a special envoy to North Korea during the George W. Bush presidency.



Independent Counsel Kenneth Starr speaks to the San Antonio Bar Association in San Antonio, Friday afternoon, May 1, 1998. With his own fight over executive privilege raging in secret, Starr today drew parallels between his plight and Watergate prosecutors. (AP Photo/Eric Gay)
ERIC GAY *AP*

Epstein also hired Bruce Reinhart, then an assistant U.S. attorney in South Florida, now a U.S. magistrate. He left the U.S. Attorney's Office on Jan. 1, 2008, and went to work representing Epstein's employees on Jan. 2, 2008, court records show. In 2011, Reinhart was named in the Crime Victims' Rights Act lawsuit, which accused him of violating Justice Department policies by switching sides, implying that he leveraged inside information about Epstein's investigation to curry favor with Epstein.

Reinhart, in a sworn declaration attached to the CVRA case, denied the allegation, saying he did not participate in Epstein's criminal case and "never learned any confidential, non-public information about the Epstein matter."

The U.S. Attorney's Office has since disputed that, saying in court papers that he did possess confidential information about the case.

Contacted for this story, Reinhart, in an email, said he never represented Epstein — only Epstein's pilots; his scheduler, Sarah Kellen; and Nadia Marcinkova, described by some victims as Epstein's sex slave. Reinhart also pointed out that a complaint filed against him by victims' lawyer Paul Cassell was dismissed by the Justice Department.

Bruce E. Reinhart, Member, McDonald Hopkins LLC. (PRNewsFoto/McDonald Hopkins LLC)
PR NEWSWIRE

That same year, 2011, more girls continued to come forward, including Roberts, who claimed in a British tabloid story that Epstein directed her — while she was underage by Florida standards — to have sex, not only with him, but with other powerful men, including his attorney, Alan Dershowitz, and Prince Andrew. Dershowitz and Andrew denied her claims, but after she filed a sworn affidavit in federal court in Miami, the ensuing news media firestorm forced Acosta, then dean of the law school at Florida International University, to explain why he'd declined to prosecute Epstein.

In a written, public statement on March 20, 2011, Acosta asserted that the deal he struck with Epstein's lawyers was harsher than it would have been had the case remained with the state prosecutor, Krischer, who favored charging Epstein with only a misdemeanor prostitution violation.

Acosta also described what he called a "year-long assault" on prosecutors by Epstein's "army of legal superstars" who, he said, investigated individual prosecutors and their families, looking for "personal peccadilloes" to disqualify them from Epstein's case.

Dershowitz, in an interview, denied that Epstein's lawyers would ever investigate prosecutors.

Documents nevertheless show that Acosta not only buckled under pressure from Epstein's lawyers, but he and other prosecutors worked with them to contain the case, even as the FBI was uncovering evidence of victims and witnesses in other states, FBI and federal court documents show.

A 53-page federal indictment had been prepared in 2007, and subpoenas were served on several of Epstein's employees, compelling them to testify before a federal grand jury. The court records reveal that emails began to fly back and forth between prosecutors and Epstein's legal team. Those emails show that federal prosecutors kept acquiescing to Epstein's demands.

Prosecutors allowed Epstein's lawyers to dictate the terms of each deal that they drew up, and repeatedly backed down on deadlines, so that the defense essentially controlled the pace of the negotiations, the emails and letters show.

It's clear, from emails and other records, that prosecutors spent a lot of time figuring out a way to settle the case with the least amount of scandal. Instead of charging Epstein with a sex offense, prosecutors considered witness tampering and obstruction charges, and misdemeanors that would allow Epstein to secretly plead guilty in Miami instead of in Palm Beach County, where most of the victims lived, thereby limiting media exposure and making it less likely for victims to appear at the sentencing.

"I've been spending some quality time with Title 18 [the U.S. criminal code] looking for misdemeanors," the lead prosecutor, A. Marie Villafaña, wrote to Epstein's lawyers on Sept. 13, 2007, adding that she was trying to find "a factual basis" for one or more non-sex-related crimes to charge him with.

The email chain shows that prosecutors sometimes communicated with the defense team using private emails, and that their correspondence referenced discussions that they wanted to have by phone or in person, so that there would be no paper trail.

"It's highly unusual and raises suspicions of something unethical happening when you see emails that say 'call me, I don't want to put this in writing.' There's no reason to worry about putting something in writing if there's nothing improper or unethical in the case," said former federal prosecutor Francey Hakes, who worked in the Justice Department's crimes against children unit.

On Sept. 24, 2007, another agreement was reached, but Epstein still wasn't happy with it, emails show.

Lefkowitz continued to pressure the U.S. Attorney's Office to keep the agreement secret, even though under the Crime Victims' Rights Act, prosecutors were required to inform the victims that a plea deal had been signed.

"We ... object to your sending a letter to the alleged victims," Lefkowitz wrote on Nov. 28. "... Any such letter would immediately be leaked to the press, your actions will only have the effect of injuring Mr. Epstein and promoting spurious civil litigation directed at him. We also request that if your office believes that it must send a letter to go to the alleged victims ... it should happen only after Mr. Epstein has entered his plea."

The girls who were abused by Jeffrey Epstein and the cops who championed their cause remain angry over what they regard as a gross injustice, while Epstein's employees and those who engineered his non-prosecution agreement have prospered.

BY MARTA OLIVER CRAVIOTTO | EMILY MICHOT | JULIE K. BROWN

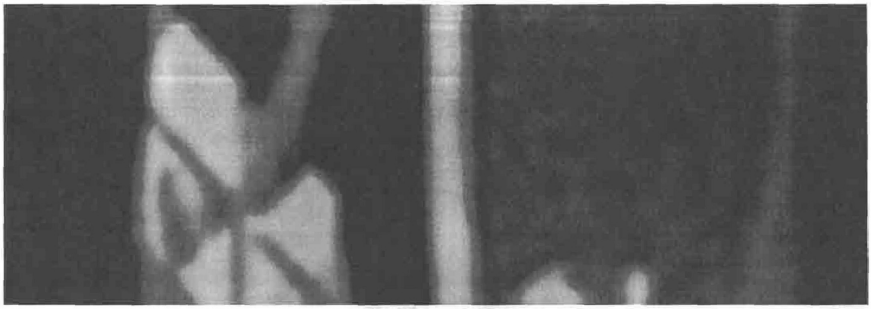
By December, Epstein had still not agreed to a date for his plea hearing, and was technically in violation of the September agreement, which required him to appear in court by November, Acosta noted in a letter to Kenneth Starr in December 2007.

"The [U.S. attorneys] who have been negotiating with defense counsel have for some time complained to me regarding the tactics used by the defense team," Acosta wrote. "It appears to them that as soon as resolution is reached on one issue, defense counsel finds ways to challenge the resolution collaterally. ... Some in our office are deeply concerned that defense counsel will continue to mount collateral challenges to provisions to the agreement, even after Mr. Epstein has entered his guilty plea and thus rendered the agreement difficult, if not impossible, to unwind."

And that's exactly what happened.

Villafaña frequently showed her frustration.

"I thought we had worked very well together in resolving this dispute. ... I feel that I bent over backwards to keep in mind the effect that the agreement would have on Mr. Epstein," Villafaña wrote to Epstein attorney Lefkowitz on Dec. 13, 2007.



By then the deal had been signed for two months, and Jeffrey Sloman, Acosta's top assistant, told Lefkowitz he intended to begin notifying Epstein's victims.

An indignant Lefkowitz wrote to Acosta: "You ... assured me that your office would not ... contact any of the identified individuals, potential witnesses or potential civil claimants and their respective counsel in this matter."

As the months went on, with the agreement still in limbo, federal prosecutors once again began to prepare indictments against Epstein, court records show. The FBI investigation briefly resumed, and additional witnesses were interviewed in New York and New Mexico, the records show. In January 2008, several Epstein victims were sent letters informing them that the FBI investigation was "ongoing" as negotiations to finalize the plea bargain continued behind the scenes.

Starr finally appealed to the Justice Department in Washington, challenging federal jurisdiction of the case, but in May 2008, the Justice Department affirmed Acosta's right to prosecute.

'STILL AFRAID OF EPSTEIN'

In recent court filings, the government was forced to answer questions about its negotiations, finally admitting in 2013 that federal prosecutors had backed down under relentless pressure by Epstein's attorneys.

"The government admits that, at least in part as a result of objections lodged by Epstein's lawyers to victim notifications, the [United States Attorney's Office] reevaluated its obligations to provide notification to victims and Jane Doe #1 was

thus not told that the USAO had entered into a non-prosecution agreement with Epstein until after it was signed," wrote Assistant U.S. Attorney Dexter Lee.

Said Hakes, the former federal prosecutor: "I have never heard of a case where federal prosecutors consult with a defense attorney before they send out standard victim notification letters. To negotiate what the letters would say and whether they would be sent at all suggest that the victims' rights were violated multiple times."

Starr's aggressive advocacy for Epstein against allegations of improper sexual behavior was in stark contrast to the path he took investigating then-President Clinton. The Starr Report, the summary of his findings in the Whitewater investigation, which started as a probe of a land deal gone sour and veered into an investigation of sexual misconduct, savaged the president for his involvement with White House intern Monica Lewinsky and was the basis for impeachment.

Starr himself would face criticism in 2016 — he stepped down as president of Baylor University amid allegations that he and other university officials mishandled sexual assault allegations brought by female students against members of the school's football team.

The Herald reached out to Starr, through certified letter and through a spokesman for his current law firm, the Lanier Firm, but did not receive a response for this story.

Palm Beach police detective Recarey, one of the most highly decorated officers on the Palm Beach Police Department, called the Epstein case the most troubling of his 23-year career.

"Some of the victims were — and still are — afraid of Epstein," he said as part of a series of interviews with the Herald earlier this year.

Privately, Reiter and Recarey said, they held onto a hope that Epstein would be brought to trial someday, but they said that that notion had faded.

"I always hoped that the plea would be thrown out and that these teenage girls, who were labeled as prostitutes by prosecutors, would get to finally shed that label and see him go to prison where he belongs," Recarey said.

Recarey died in May after a brief illness. He was 50 years old.

More from the series

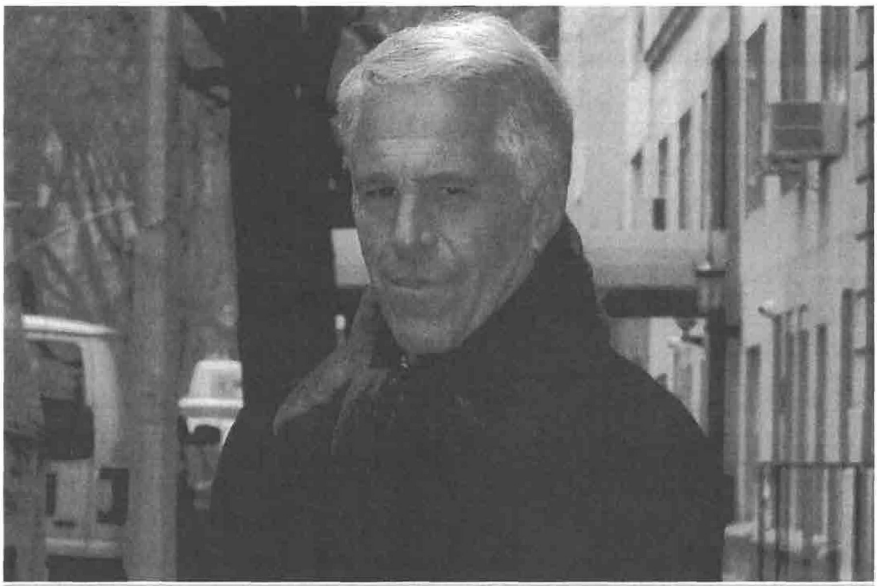
How a future Trump Cabinet member gave a serial sex abuser the deal of a lifetime

EXHIBIT B

DA's office 'went easy' on sex offender Epstein

By Rebecca Rosenberg and Danika Fears

January 7, 2015 | 2:38am



Jeffrey Epstein
Gregory P. Mango

Jeffrey Epstein may be a convicted pedophile and accused sex- slave master — but that didn't stop him from getting some tender loving treatment from the Manhattan DA's Office.

Prosectors went to bat for the billionaire pervert at a 2011 legal hearing, asking a judge to cut the filthy- rich felon a break on the severity of his sex- offender status, according to court documents.

ADA Jennifer Gaffney supported a request by Epstein — who allegedly peddled $15,000-a-night teen "sex slaves" to rich men like Britain's Prince Andrew — that he only be listed as a Level 1 pervert during a hearing in Manhattan Supreme Court, according to legal transcripts.

The sicko investment magnate has just finished serving 13 months of an 18-month sentence in Florida for soliciting a minor girl for prostitution. The hearing was to determine what kind of offender status he would have in New York, where he keeps a vacation home.

The city ADA argued that since "there was only an indictment for one victim," Epstein shouldn't have to register as Level 3 — which would require he travel to New York every 90 days and check in with cops.

Judge Ruth Pickholz was flabbergasted. She couldn't understand why the DA would want to go easy on Epstein, after the New York State Board of Examiners of Sex Offenders recommended the Level 3 status because there was more than just the one victim for which he pleaded guilty.

"I have to tell you, i'm a little overwhelmed because I have never seen the prosecutor's office do anything like this," the judge said at the hearing.

Despite the DA's arguments, Pickholz slapped Epstein with Level 3 status, which was upheld on appeal.

"The strong evidence that the offenses against the other victims did occur outweighs any inferences to be drawn from the manner in which this case was prosecuted in Florida," the New York Court of Appeals said in its ruling.

When asked for comment, the DA's Office referred The Post to court documents stating that the prosecution's position was based "largely on the mistaken notion" that only the formal charges against Epstein could be factors in the decision.

The jet-setting financier has been making headlines in recent days after Virginia Roberts, 30, claimed he pimped her to Britain's Prince Andrew.

Prince Andrew has denied the accusations against him.

FILED UNDER **JEFFREY EPSTEIN, PRINCE ANDREW, VIRGINIA ROBERTS**

Recommended by

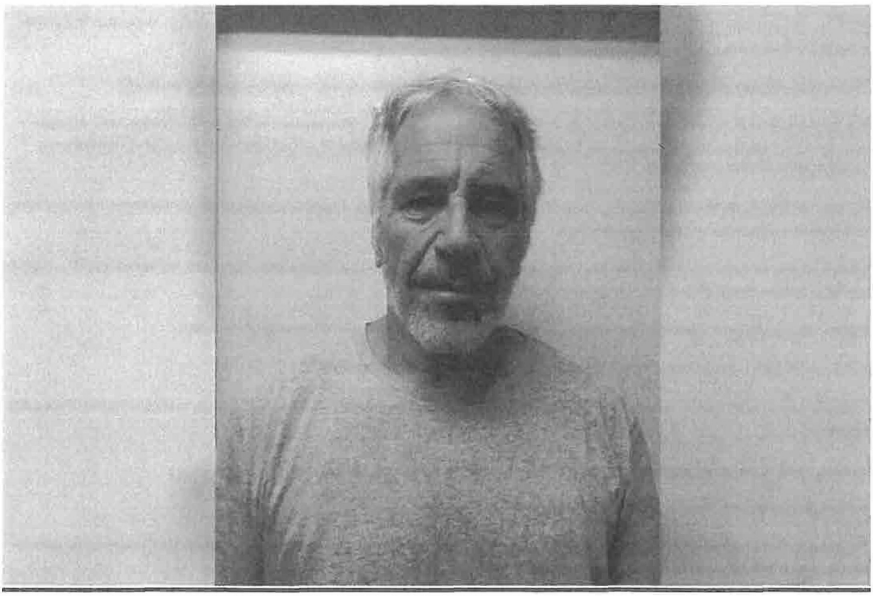
EXHIBIT C

METRO

Manhattan DA sided with pedophile billionaire after botching investigation

By Rebecca Rosenberg, Larry Celona, Susan Edelman and Isabel Vincent

December 1, 2018 | 8:47pm | Updated



Jeffrey Epstein

The Manhattan DA's office once went to bat for billionaire pervert Jeffrey Epstein, after botching a review of his sex crimes and swallowing his lawyers' claim that "there are no real victims here," records obtained by the Post show.

Assistant DA Jennifer Gaffney, then-deputy chief of Cyrus Vance Jr.'s sex-crimes unit, in January 2011 asked a Manhattan judge to downgrade Epstein's status in the New York sex-offender registry from the most-dangerous Level 3 to least-restrictive Level 1.

The judge was stunned.

"I have never seen the prosecutor's office do anything like this," Manhattan Supreme Court Justice Ruth Pickholz told Gaffney. "I have done many [cases] much less troubling than this one where [prosecutors] would never make a downward argument like this."

Pressed by the judge, Gaffney admitted that she never spoke to the Florida U.S. Attorney who handled a sprawling sex-crime investigation into the financier.

"I don't think you did much of an investigation here," Pickholz said. "I am shocked."

Vance's mishandling of the Epstein hearing has come under new scrutiny after a Miami Herald report last week revealed a secret "non-prosecution agreement" in Florida that buried evidence Epstein had allegedly pimped out 80 girls and young women to his rich and powerful pals.

The DA's office insists Vance "was not aware" of the hearing until years later and had nothing to do with it.

"Our prosecutor made a mistake," Vance spokesman Danny Frost said of Gaffney.

Gaffney, a prosecutor working in the Harvey Weinstein probe, left the DA's office in September. She declined to comment.

A DA insider said the office was unaware of Epstein's secret plea deal in Florida, and never investigated his sexcapades in NYC.

Some law enforcement sources don't believe Vance had no clue that his office had a sex-offender case involving a Manhattan mogul with close ties to Democrats.

"This is very unusual," one said. "There is no way Vance didn't know. The question is why — and who asked for the favor."

The FBI found Epstein recruited girls as young as 13, many runaways, from Florida, New Mexico, the Caribbean and New York, and paid them for nude massages that often led to sex, the Herald reported. Some girls worked for a Manhattan modeling agency and lived in a nearby apartment owned by Epstein.

But Miami U.S. Attorney Alexander Acosta — now President Trump's labor secretary — sealed a 53-page federal indictment that could have sent Epstein to prison for life, the Herald reported.

Instead, Acosta let Epstein plead guilty to procuring a person under 18 for prostitution. Sentenced to 18 months, he served just 13 — most of it in his tony Palm Beach office.

Epstein was required to register as a sex offender in New York because one of his many homes is in Manhattan.

In the Jan. 18, 2011 hearing, Gaffney argued the evidence didn't justify the harshest status.

"There is only an indictment for one victim,," she said. "If an offender is not indicted for an offense, it is strong evidence that the offense did not occur."

Pickholz rejected Gaffney's arguments and gave Epstein the highest sex-offender status – Level 3.

When Epstein appealed, Vance's office admitted it had misread the law.

The appellate court upheld Pickholz, saying Epstein "committed multiple offenses against a series of underage girls," and that the victim in his indictment "was only one of defendant's many victims."

FILED UNDER **BILLIONAIRES**, **DISTRICT ATTORNEYS**, **JEFFREY EPSTEIN**, **PEDOPHILES**, **SEX OFFENDERS**

Recommended by

EXHIBIT D

From: **Frost, Danny** <frostd@dany.nyc.gov>
Date: Thu, Dec 6, 2018 at 5:27 PM
Subject: RE: request
To: Susan Edelman <sedelman@nypost.com>

Hi Sue,

Regarding your first question: pursuant to Civil Rights Law § 50-b, our office's practice in appellate sex crimes matters is to file documents under seal. This is not particular to People v. Epstein; it is routine across our appellate filings. My understanding is that it is also the Appellate Division's (the court's) practice to maintain such seal.

That being said, I have discussed your second question with our attorneys. If the Post petitions the court, and the court asks the People for our positon, we will *not* oppose the petition for a redacted brief.

Thanks.

Danny Frost
Director of Communications
Manhattan District Attorney Cy Vance, Jr.
212-335-9400 // @ManhattanDA

From: Susan Edelman [mailto:sedelman@nypost.com]
Sent: Thursday, December 6, 2018 9:12 AM
To: Frost, Danny <frostd@dany.nyc.gov>
Subject: Re: request

Hi Dan,

Please explain why the DA's office didn't file a redacted brief, but rather covered up all the facts.

If we filed a petition for a redacted brief, would the DA's office fight it or cooperate?

Thank you,

Sue

Susan Edelman

Reporter

1211 Avenue of the Americas, New York, NY, 10036

917-584-7675

sedelman@nypost.com

On Wed, Dec 5, 2018 at 3:45 PM Frost, Danny <frostd@dany.nyc.gov> wrote:

Hi Sue – the document was filed under seal. I cannot violate the seal and provide it to you.

(off the record please) You may wish to petition the court, or have the Post's lawyer send our lawyers something. We've reached the end of me being able to help – it's sealed.

Danny Frost
Director of Communications
Manhattan District Attorney Cy Vance, Jr.
212-335-9400 // @ManhattanDA

From: Susan Edelman [mailto:sedelman@nypost.com]
Sent: Wednesday, December 5, 2018 3:06 PM
To: Frost, Danny <frostd@dany.nyc.gov>
Subject: Re: request

Right, but the law allows for the redaction of victim names. Where does it say the whole document is denied?

Susan Edelman

Reporter

1211 Avenue of the Americas, New York, NY, 10036

917-584-7675

sedelman@nypost.com

On Wed, Dec 5, 2018 at 3:02 PM Frost, Danny <frostd@dany.nyc.gov> wrote:

Hi Sue - this is prescribed by Civil Rights Law § 50-b.

Danny Frost
Director of Communications
Manhattan District Attorney Cy Vance, Jr.
212-335-9400 // @ManhattanDA

From: Susan Edelman [mailto:sedelman@nypost.com]
Sent: Wednesday, December 5, 2018 2:58 PM
To: Frost, Danny <frostd@dany.nyc.gov>
Subject: Re: request

Hi Dan,

So it was a unilateral decision by the DA to seal the document?

There was no hearing or opportunity to object?

Thank you,

Sue

Susan Edelman

Reporter

1211 Avenue of the Americas, New York, NY, 10036

917-584-7675

sedelman@nypost.com

On Wed, Dec 5, 2018 at 2:55 PM Frost, Danny <frostd@dany.nyc.gov> wrote:

Hi Sue – we do not have a court order; rather, we are bound by the Civil Rights statute cited on the cover page. Thanks.

Danny Frost
Director of Communications
Manhattan District Attorney Cy Vance, Jr.
212-335-9400 // @ManhattanDA

From: Susan Edelman [mailto:sedelman@nypost.com]
Sent: Wednesday, December 5, 2018 1:47 PM
To: Frost, Danny <frostd@dany.nyc.gov>
Subject: Re: request

Thanks,, Is there a specific date?

Do you have a court order sealing the document?

Susan Edelman

Reporter

1211 Avenue of the Americas, New York, NY, 10036

917-584-7675

sedelman@nypost.com

On Wed, Dec 5, 2018 at 1:44 PM Frost, Danny <frostd@dany.nyc.gov> wrote:

August 2011

Danny Frost
Director of Communications
Manhattan District Attorney Cy Vance, Jr.
212-335-9400 // @ManhattanDA

From: Susan Edelman [mailto:sedelman@nypost.com]
Sent: Wednesday, December 5, 2018 1:38 PM
To: Frost, Danny <frostd@dany.nyc.gov>
Subject: Re: request

P.S. What is the date of this document?

Susan Edelman

Reporter

1211 Avenue of the Americas, New York, NY, 10036

917-584-7675

sedelman@nypost.com

On Wed, Dec 5, 2018 at 1:02 PM Susan Edelman <sedelman@nypost.com> wrote:

Thanks, Danny,

Is there a judge's order sealing this document?

Or is it just stated by the DA's office.

It's unclear on this cover page.

Sue

Susan Edelman

Reporter

1211 Avenue of the Americas, New York, NY, 10036

917-584-7675

sedelman@nypost.com

On Wed, Dec 5, 2018 at 12:55 PM Frost, Danny <frostd@dany.nyc.gov> wrote:

Attached, thanks.

Danny Frost
Director of Communications
Manhattan District Attorney Cy Vance, Jr.
212-335-9400 // @ManhattanDA

From: Susan Edelman [mailto:sedelman@nypost.com]
Sent: Wednesday, December 5, 2018 12:41 PM
To: Frost, Danny <frostd@dany.nyc.gov>
Subject: Re: request

Hi Dan,

It's for my information -- not publication.

Thanks much,

Sue

Susan Edelman

Reporter

1211 Avenue of the Americas, New York, NY, 10036

917-584-7675

sedelman@nypost.com

On Wed, Dec 5, 2018 at 12:38 PM Frost, Danny <frostd@dany.nyc.gov> wrote:

Hi Sue – would I be sending the cover page for publication, or for your information? I am happy to send it to you not-for-publication, but if you intend to publish it, I need to check with our lawyers. Thanks.

Danny Frost
Director of Communications
Manhattan District Attorney Cy Vance, Jr.
212-335-9400 // @ManhattanDA

From: Susan Edelman [mailto:sedelman@nypost.com]
Sent: Wednesday, December 5, 2018 12:35 PM
To: Frost, Danny <frostd@dany.nyc.gov>
Subject: Re: request

Hi Danny,

Thanks. Can you send me a PDF of the cover page?

Who issued that order?

We always get such court documents -- with the names and ID of victims redacted.

The whole document is not withheld.

Sue

Susan Edelman

Reporter

1211 Avenue of the Americas, New York, NY, 10036

917-584-7675

sedelman@nypost.com

On Wed, Dec 5, 2018 at 12:28 PM Frost, Danny <frostd@dany.nyc.gov> wrote:

Hi Sue – I've confirmed that the brief is filed under seal. It contains the following header on the cover page: "Pursuant to Civil Rights Law § 50-b, the identities of the victims, who are the victims of sex offenses, shall be confidential, **and this document shall not be made available for public inspection.**"

Accordingly we must decline your request. Thanks.

Danny Frost
Director of Communications
Manhattan District Attorney Cy Vance, Jr.
212-335-9400 // @ManhattanDA

From: Susan Edelman [mailto:sedelman@nypost.com]
Sent: Tuesday, December 4, 2018 6:34 PM
To: Frost, Danny <frostd@dany.nyc.gov>
Subject: request

Hi Danny,

Following up on the Epstein case:

Can you send me the DA's appellate brief in the sex-offender registry case?
I understand you may have to redact the names of any victims.

Please let me know as soon as possible.

Thank you,

Sue

Susan Edelman

Reporter

1211 Avenue of the Americas, New York, NY, 10036

917-584-7675

sedelman@nypost.com

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EXHIBIT E

SUPREME COURT OF THE STATE OF NEW YORK
APPELLATE DIVISION: FIRST DEPARTMENT

THE PEOPLE OF THE STATE OF NEW YORK, Respondent, -against- JEFFREY E. EPSTEIN, Defendant-Appellant.	AFFIRMATION IN RESPONSE TO MOTION N.Y. Co. Ind. No. 30129/10 Cal. Date: December 31, 2018

KAREN FRIEDMAN AGNIFILO, an attorney duly admitted to practice before the courts of this State, affirms under penalty of perjury that:

1. I am an Assistant District Attorney, of counsel to CYRUS R. VANCE, JR., District Attorney of New York County, and I submit this affirmation on behalf of the People in response to a motion filed by non-party movant NYP Holdings, Inc. (the "Post") to "unseal" the appellate briefs from 2011, pertaining to the adjudication of defendant Jeffrey E. Epstein as a Level III sex offender under the Sex Offender Registration Act ("SORA"). Civil Rights Law § 50-b provides that the identities of the victims of sex offenses must remain confidential and that documents bearing identifying information should not be made available for public inspection. Despite those protections, the Post seeks copies of the appellate briefs, with the names or initials of Epstein's sex crimes victims redacted, for use in reporting about the procedural history underlying defendant's SORA adjudication.

2. In order to protect the privacy interests of victims of sex crimes, the plain language of Civil Rights Law § 50-b prohibits production to the public of the appellate briefs, which would reveal the identities of many of defendant's sex crime victims. To be sure, the statute provides for a narrow exception to the confidentiality requirement, permitting disclosure, by court order, of information for "good cause" and upon "notice to the victim... and the public officer or employee charged with the duty of prosecuting the offense." Civil Rights Law § 50-b(2)(b). We note that the prosecuting agencies for defendant's underlying sex crimes are the federal and local prosecutor's offices in Florida, where defendant was charged. By all appearances, the Post has yet to furnish the requisite notice to either the appropriate prosecuting agencies or to the victims themselves. And to the extent that the Post is unable to furnish notice to the victims, this Office, which was not the prosecuting agency, is not in a position to do so.

3. In any event, and in keeping with the People's obligation under Civil Rights Law § 50-b to protect the privacy of the victims of sex crimes, we cannot agree to the wholesale production of the People's appellate brief or even to a production of the People's brief with redactions of the names or initials of Epstein's victims.[1] However, if this Court is inclined to grant the Post's motion, we would not oppose producing a copy of the People's brief, with substantial redactions necessary to protect the identities of the victims but keeping

[1] According to the Post's filing, they have contacted defendant's current counsel, who has reserved the right to oppose the disclosure of defendant's appellate brief.

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intact those portions of the brief that recount the procedural history of the SORA hearing, the portion of the brief that is seemingly of interest to the Post.

Dated: New York, New York
December 28, 2018

KAREN FRIEDMAN AGNIFILO
Assistant District Attorney
(212) 335-9000

cc: Davis Wright Tremaine LLP
John M. Browning
1251 Avenue of the Americas, 21st Floor
New York, New York 10020-1104

HOUSE_OVERSIGHT_016476